Vol.1 No.2

December 15, 2008

An IIT Kanpur students' publication

NERD

Notes on Engineering Research and Development

Dr.S.Raychaudhuri talks about LHC

Interview with Dr. A. K. Mallik

GASE : Making India energy independent

Gems of geometry

https://lhc2008.web.cern.ch/LHC2008/images/lhc-fond.jpg

NERD HERD

Fireflies and other undecimal stories

India has reached the moon. **Chandrayaan** is in lunar orbit and the Moon Impact Probe has made a successful impact-landing on earth's only natural satellite. NERD Team was at a special lecture organized by Astronomy Club on November 8, 2008 when the news of the mission entering the lunar orbit came in. With the payloads deployed successfully, Chandrayaan has become the epitome of India's newfound sense of possibilities. ISRO is now working on Chandrayaan 2 now which will involve a lunar orbiting spacecraft and a Lander/Rover for more detailed study of lunar environment.

JUGNU

Back here on Earth, IIT Kanpur's foray into space research is also progressing with its own satellite mission. A team of students is working under the guidance of a multi-discplinary panel composed of IIT Kanpur faculty members and ISRO experts to build this satellite which would be launched by ISRO's Polar Satellite Launch Vehicle at a suitable time during the Golden Jubilee celebrations. The satellite, provisionally called **JUGNU** (Hindi for '*firefly*') will carry a micro GPS device, an Inertial Measurement Unit developed in IIT Kanpur and Micro Imaging System. This mission will help IIT Kanpur develop basic competencies required for satellite engineering thus creating a platform for all future missions. Project's annual progress will be reported in the April issue (Vol. 1 No. 4) of NERD.

Proton chops and primordial soup

The largest machine in the history of mankind went functional. Yes, the **Large Hadron Collider (LHC)** went functional on September 10, 2008 when proton beams were successfully circulated in the main ring of the LHC for the first time. Although the operations were halted a little more than a week later due to serious faults in LHC's superconducting magnets, LHC remains a key scientific milestone of this year. The facility will be functional from summer 2009. More details about the Indian contribution in LHC inside.

Particle Bash on Campus

IIT Kanpur made its own stride in particle acceleration with inauguration of the **Tandetron Ion Beam** facility on September 27, 2008 under the supervision of Dr. V.N. Kulkarni of Department of Physics. This has increased hope for in-house accelerator development at IIT Kanpur some time in future. The accelerator operates energies of at 1.7 MeV and will facilitate research in many different fields. More details inside.

GASE

Talking of energy, students have started a research group for alternative sources of energy called the **Group for Alternative Sources of Energy (GASE)** with the long term vision of an energy independent India. Read more about the group in an exclusive introduction inside.

Research emPoWERed

Meanwhile, taking note of the efforts like GASE and Dhwani, the institute has envisaged a scheme for supporting student driven projects that have a strong component of design, synthesis and operation (**technology demonstrators**). Proposals for such projects have been invited. The scheme, launched by the Dean of Research and Development (DORD), will become operational from 1st April 2009. It has been proposed that a total of 2-3 projects will be accepted annually and supported from a budget of Rs 1-2 crores set aside for this purpose. We hope that this step will certainly provide a boost to students' research in the institute.

NERD – third coming

More student research means more quality content for NERD. Powered by DORD's latest announcement, NERD team has begun work on the **Volume 1 Number 3**. It will focus on the energy and environment sector with an emphasis on alternative sources of energy and the related research that is going on in the institute. We plan to launch the third issue during Techkriti 2009, which is also themed on energy.

NERD also calls for articles from other institutes through Eureka (the paper presentation contest in Techkriti 2009)- *http://www.techkriti.org/#/competitions-focus-eureka-nerd/*

More wings

Another encouraging development took place when the Institute Research and Development Committee, in principle, agreed to a proposal for organizing a national level undergraduate research conference christened **Indian Conference for Academic Research by Undergraduate Students (ICARUS)**. The proposal was presented to them in a maiden student presentation on October 17, 2008. The presentation on NERD was also made in the same meeting by another student.

God of small things

The **DST unit on Nanosciences** will be inaugurated on December 7, 2008. NERD will be following up on the unit in the next issue. The Unit will be coordinated by Professor Ashutosh Sharma of Chemical Engineering. He is also a Review Board member on NERD. The **Indo-US Science and Technology Forum Initiative on Fabrionics** will also be launched on the same day.

Parting note

And before we leave, another update: **2008 Nobels** have been announced. On October 7, 2008 the Royal Swedish Academy of Sciences ceded the awards. For more details, do not forget to log on to *http://nobelprize.org/* .

With this we give you Vol. 1 No. 2 of NERD. Do not forget to send your frank reviews at *nerd@iitk.ac.in*. And yes… keep thinking!

CONTENTS:

WIRED

This is the feedback column of NERD. Various comments, general or article specific, that we receive at *nerd@iitk.ac.in* will be published here with occasional replies from the **NERD**. Feel free to express your views. Here are the comments that NERD received for its inaugural issue:

"Congratulations to NERD team for putting together a nice blend of state of the art article(s) covering fundamental aspects. I am sure that your initiative will soon mature to a highly informative engineering R&D magazine of the institute." **Professor R. K. Thareja, Deputy Director, IIT Kanpur.**

"Very good effort both in students' research and NERD publication. Let a couple of more issues come then certain things will become more known and certain strategic and formal decisions can be taken." **Professor Kripa Shankar, Department of Industrial and Management Engineering IIT Kanpur.**

"I really liked the format and articles in issue 1 of NERD. You all have worked hard. Keep up the great work. Wish you all the very best in future." **Professor Ashutosh Sharma, Department of Chemical Engineering IIT Kanpur.**

"I must congratulate your novel and meaningful initiative. This issue of NERD is really impressive. " **Professor Kumar Ravi Priya, Department of Humanities and Social Science IIT Kanpur.**

"It was especially heartening to see the first serious student-inspired initiative on R&D. The first issue was indeed topical and we hope that you will continue to highlight the cutting edge research and development ideas pursued by our students. However, the key issue is sustainability!!!" **Professor Rajiv Shekhar, HOD, Department of Materials and Metallurgical Engineering IIT Kanpur.**

"Good work! Keep it up. To sustain NERD, highlight the need of seriousness in research (and the lack of it). Ensure that only original research work gets the due attention. Encourage original thinking through it." **Professor F.A. Khan, Department of Chemistry IIT Kanpur .**

"Congratulations to the NERD team for a wonderful initiative and a job well done. Please do not hesitate in contacting me to discuss future directions and articles." **Professor M. K. Harbola, Department of Physics IIT Kanpur.**

"Congratulations on this excellent work. The presentation is beautiful.

The context of research is different from the view point of the reader. What may appeal to a first year UG student may not be appealing at all to a Master's student or a PhD student. What I am trying to say is that the material may be sorted on the basis of the complexity of the work and printed accordingly. A good mix of general topics vs. specialized topics is a good idea." **Professor Rajat Moona, Department of Computer Science and Engineering IIT Kanpur.**

"Thank you for sending the inaugural issue of your news magazine and I shared it with all the students in our lab. I thought that this was a much needed forum in an academic institute like IIT. Unfortunately, most of the time the tail wags the dog and the core purpose of our existence in an academic environment is too often forgotten, to the detriment of society at large. In an age where "financial engineering" has taken over the real science and engineering - it is refreshing to see your endeavor. I wish you all the best." **Professor Tapan Sengupta, Department of Aerospace Engineering IIT Kanpur.**

"This is an excellent effort : it was a proud feeling that I experienced on the day this effort was inaugurated (Teachers' Day)." **Professor Lilavati Krishnan, Department of Humanities and Social Science IIT Kanpur.**

"It is a very good effort but please make sure about its sustainability." **Professor A. Biswas, Department of Electrical Engineering IIT Kanpur.**

Turn to page 36 to read what students have to say about NERD

Passion is the key

Interview with Dr. A.K. Mallik

Mohit Jolly and Sambhav Karnawat

Department of Mechanical Engineering at IIT Kanpur is versed with some of the best teachers in the world. ***Dr. A. K. Mallik*** *is one of them. The passion with which he teaches in his class, the meticulous attention his fascinating experiments attract and his noble behavior makes him the apple of each eye. He has been in this institute since 1971. NERD team gets a chance to have an exclusive interview with him (and also learn the theory behind a seemingly simple experiment). Here are some of the excerpts:*

NERD: Sir, you have been in this institute as a faculty member for over three decades. What is the most striking feature of IIT Kanpur you have noticed?

Dr. Mallik: It is close to four decades now- 37 years. (Smiles) Academic freedom is enormous at IIT Kanpur. I have been at IIT Delhi for some time, but the ambience of academics that I have witnessed here is unique.

Dr. A. K. Mallik

NERD: You have been a witness to the infrastructure development of IIT Kanpur since long. What trend have you witnessed in participation of students in technical activities here?

Dr. Mallik: Outside the class technical activities have gone up significantly. With the start of Techkriti in mid 90's, group technical activities have been on a rise. No student used to stay in summers to do projects till late 90's, but now the trend is changing. Some UG students have recently done good publishable work. At the same time, class participation has declined considerably from that in 70's and 80's.

NERD: You are well known with students for teaching through experiments in class. Please elaborate on some of your favorite experiments.

Dr. Mallik: Maximum things I purchase are toys. They fascinate me. Once I visited a German fair in 1983 and a toy caught my attention. I returned to India and got it made from a carpenter. (He took out the toy and showed us the experiment.) See, the toy came in 1983 but the theory which explains this toy came out in 2001.

A boiled egg when rotated rapidly stands up vertically. Various papers have been written to explain this phenomenon since long. Such visual experiments rekindle the thought process in a much better way. Students have always loved these demonstrations in class because although I kept on aging, students I teach are of the same age. (Smiles) I showed some simple experiments on mechanics in REACH Symposium as well.

We must realize that subject is only a medium, whereas academics is an exercise for our brain. We are using our brain all the time, so we need some exercise too to replenish it.

NERD: Many students love and respect you for the way you have been teaching the course on vibrations. You also received the Distinguished Teacher Award in 2004. What pedagogical techniques adopted by you made you so different?

Dr. Mallik: I have my own way of teaching. I always posed those questions to students which came to my mind. Say, for a core course, I asked students to question themselves "Why should I learn this course? Where does it fit into the whole programme of my B.Tech degree?" The answer is that there must be something very basic in that course which every mechanical engineer should know. This is the motivation I have been giving to my students to learn.

Once, I was asked to write a short write up for a book 'Secrets of Good Teaching'. I prepared it but could not think of any title. 'Passion is the key' was the title the editor gave to that write up.

I tell in class that classification is a part of knowledge, but not the motivation. Everything can be learnt, but nothing can be taught. Teacher is just a facilitator. If learning is entirely exam oriented, it is not worth to be called learning. This is the reason, I hate grading even after 37 years.

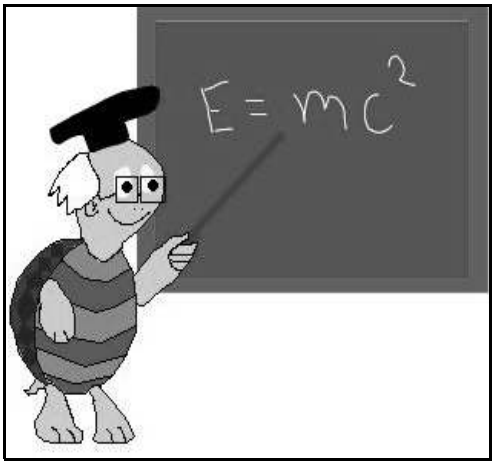
NERD: Please tell about some of your interesting experiences in class.

Dr. Mallik: It has always been a privilege teaching in this institute. I remember a very brilliant student, but not so punctual. I have always been very strict with timings in my class. Once when he was late for class, I allowed him to enter but gave him a good thrash. I allowed him because he, in each class, would ask some question to which I was never ready to answer spontaneously. He would never take notes, yet I could read his face when he was going to point me out.

"I hate grading even after 37 years."

Those days I always gave one question in exam which I did not do at first time. Now I have been soft in setting the question paper. In an exam, the questions were in a sequel, so that if you get the first question wrong, the remaining ones go wrong. I also kept the solutions during the exam and kept the option that students may look into the solution of the question (s) they want, but they shall lose credit for it. In last 20 minutes of that exam, I ran several kilometers in L-7 when students started asking for solutions to confirm theirs. Such an experiment is not possible now. The ambience has changed.

Once I set a question in my paper which I expected only some students to solve correctly. I was standing by a very brilliant student. I wanted to see what approach he was following to solve it. I kept on standing there. After 20 minutes, he said- "Sir, why are you disturbing me?"



NERD: You were the chairman of the previous UGRC (Under Graduate Review Committee) in 2000. What changes were recommended by UGRC then?

Dr. Mallik: UGRC in 2000 recommended 3 major decisions. We ensured that the maximum load in a semester is not beyond a certain limit. The course on communication skills was introduced as we have been receiving feedback that our students are not so good at them. Science Electives (SE) were introduced so that the students have an opportunity to learn about modern advanced streams of science as well besides the engineering courses.

NERD: Does it not sound ironical that UGRC has no student opinion?

Dr. Mallik: We held two long meetings with around 40 students from each batch, but only after some of our plans took shape. In the period of two years given to UGRC to submit its report, we had these meeting with student body at large after 15 months to express their opinion on our recommendations. We put forward the plan to reduce the number of mid semester examinations in a semester to one and limit number of quizzes, but a very large majority of students turned it down.

NERD: You have been involved with students as DOSA, Head Counselling Service and DUGC Convener. What has been your experience with student participation in student governance activities?

Dr. Mallik: In my tenure as DOSA, the President, Students' Gymkhana and the Convener, Students' Senate were very active, vehement, highly vocal and behaved decently. Gymkhana elections were taken very seriously and students with a very high CPI also involved themselves in governance activities.

I have never been keen on administration. When students asked for the resignation of DOSA, DD and Head CS in 1986, the President and the Convener came to my house and requested me not to resign. They told me that since they could not ask only for the resignation of Head CS, so they had to include DOSA as well in their list, but I submitted my resignation the very next day.

NERD: Sir, you have witnessed 4-year B.Tech program as well as 5-year B.Tech program. What changes in curriculum were made to compress the duration by an year and how has that affected the education?

Dr. Mallik: This change had a very huge impact on entire UG program of the country. There was hardly any reduction in total no. of courses required for graduation. More of the science component was pushed into school level. Most of the schools could not do justice to it, and the level of JEE went up. There was a mushrooming of coaching centers all around the country, which murdered the school education.

Students adopted 2 different paradigms of study- JEE and class 12. JEE became the aim and the most important part of academic curriculum for them. This was most damaging.

NERD: You have been a brilliant scholar too. Do you think that the UG community of students today at IIT are building the brand name of IIT Kanpur or just feeding on it?

Dr. Mallik: From the class participation of students, I would say that on an average, students of UG community today are not showing that promise. The taste of academics has been lost. Students earlier too opted for careers other than academics, but at least they participated well in class.

"JEE became the aim of students. This was most damaging."

NERD: What is your take on UG research?

Dr. Mallik: No component of research should be made mandatory in UG programme. UG curriculum is for your overall development and to keep your thinking process intact so that you can pursue research if you are interested. The courses need to be made more interesting.

NERD: You are in the last phase of your career as a faculty. What one thing would you like to accomplish in remaining years? What are your plans after retiring as a faculty?

Dr. Mallik: I have taken voluntary retirement and I shall be leaving in June 2009. I don't want any personal accomplishment and I have no career plans. I will continue teaching depending on my health rather than doing research.

"We never discussed absenteeism in classes till 90s."

NERD: Describe Dr. A.K. Mallik in one line.

Dr. Mallik: (Thinks) I speak exactly as I feel. If I like something, I am all for it. If I disapprove something, it is visible in my harsh words. I am a transparent being.

NERD: What is your final message to the students?

Dr. Mallik: Is there really such a lack of interest that is causing absenteeism? Why are students not attending classes these days? Please figure out, pinpoint and change things that will rectify this problem, if you really want to retain good motivated breed of teachers. It is worse from the teacher's side if you miss his/her classes. He/she gets highly demotivated. Students are equally responsible for maintaining their passion of learning as teacher's passion for teaching. If a teacher is not teaching well, please be free to tell him/her regarding it. I am not talking of the feedback form which is asked to be filled in 5 minutes. Be informal and courageous enough.

We never discussed absenteeism in classes till 90s. The situation is getting pathetic day by day. Please redress the situation; else this institute will be deprived of good teachers very soon.

NERD: Thank you Sir! It was a great pleasure talking to you.

Dr. Mallik: Most welcome.

Mohit Jolly (mkjolly@iitk.ac.in) is a third year undergraduate student in the Department of Biological Sciences and Bioengineering. He is interested in bioinformatics and biomechanics. He was recently declared the 'Best Journalist' in a workshop conducted by correspondent from HT Café, Mumbai.

Sambhav Karnawat (sambhavk@iitk.ac.in) is a second year undergraduate in the Department of Mechanical Engineering Department. He is interested in programming and simple experiments based on daily applications of science.

Professor A.K. Mallik is the first occupant of the "Professor S. Sampath Chair" at IIT Kanpur. His research interests include Analysis and Control of Mechanical Vibration, Nonlinear Dynamics, Kinematics and Robotics.

He has taught many UG as well as PG courses, mainly in the broad area of Mechanics. These include Mechanics of Solid, Theory of Mechanisms and Machines, Dynamics, Vibrations etc. He has actively participated in the first year course on Physics. He has fabricated a large number of teaching (visual) aids, two educational movies- one of which (Vibration) was transmitted several times by the UGC National Programme of Doordarshan, and the other one on "Four-bar Coupler Curves"; and a forty–lecture video course on Kinematics of Machines for transmission in Eklavya channel of Doordarshan under NPTEL project (National Programme on Technology Enhanced Learning). Lately he is involved in a series of popular lectures on Elementary Mathematics.

Get smart with 'Smart Cards'!

Smart Card Identification system developed at IIT Kanpur

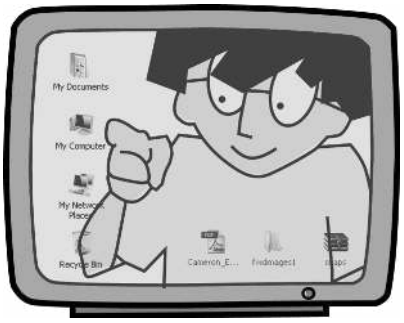
Avirishu Verma

Introduction

Smart Card, the youngest and cleverest I-card, is a simple pocket-sized card embedded with computer chip that transmits, stores and processes data. Truly named, it is a single card with multiple applications. Your own student ID card is a smart card!

IIT Kanpur has introduced Smart card identification system, developed and designed here itself, under the guidance and leadership of Professor Rajat Moona (Department of Computer Science and Engineering). This technology has been implemented successfully in IIT Kanpur as well as in various other organizations. Their implementation has been done through National Informatics Center, External Affairs Ministry and industries like Infineon India Limited, NXP.

So what's a Smart Card ?



A Smart Card has a microprocessor and a memory chip embedded in it which can store and process data as and when required. The software program installed in it gets activated when the card is inserted into its reader which is a part of some computing system. IIT Kanpur Smart ID cards are built on *SCOSTA (Smart Card Operating System for Transport Applications)* standards for the card operating system. SCOSTA is a nation-wide standard originally designed by IIT Kanpur for transport applications and currently being used in Driving License and Vehicle Registration Certificate throughout the country.

The information stored on the IIT Kanpur ID card includes the following:

1. ID related information
2. Keys and passwords
3. Access control information
4. Various check sums for data integrity
5. Personal information

Uses

Being a portable computational device with data storage abilities, smart card finds use in a vast variety of areas, be it concerned with security issues like user authentication or any other application requiring data transaction in a secured manner.

With Smart card used as an ID card, new secure techniques are used in various ID related applications such as:

1 Library management system
2 Access control system
3 Student attendance system,
4 E-Cash applications.

Smart Cards have also been used in driving licenses, vehicle registration certificates and as Multipurpose National ID cards (MNICs). They are also being used in network security (using smart cards for storing secure web certificates) and protecting digital television streams.

They offer many advantages compared to magnetic strip cards used in Bank ATM cards, driving licenses and Credit Cards. One of the important advantages is that storage data can be protected against unauthorized access and modification.

Developments, Data Security and Future Direction

Some special smart cards need not be inserted into the reader for data transaction have sensors. They operate from a distance, and are called *Contactless Smart Cards.* These can be used in transportation and/or door locks. The concept of *'electronic passports'* containing a chip embedded in the binding of the passport is also a major development.

On June 26, 2008, the Ministry of External Affairs, India inaugurated the electronic passports using technology developed by IIT Kanpur. The electronic passports were given to the President, Vice-president, Prime Minister and other important functionaries. The minister of external affairs is now giving electronic passports to the diplomats and officials. The scheme will be extended to general public by October 2009.

Smart Cards will soon be used in *financial inclusion schemes*, i.e. microfinancing schemes too. These schemes involve the delivery of banking and other financial services at an affordable cost to the vast sections of disadvantaged and low income groups.

Smart Cards store and transmit information with high security. The use of cryptographic techniques makes the data inaccessible to unauthorized users. The cryptographic key used to store data remains secure- only the result based on the data is shown and not the data itself. It can be considered something like a password; it is never known but is always used for verification. Symmetric-key cryptography has been used in smart cards designed here. Prof. Moona opines that the implementation of asymmetric key cryptography will make them more usable. Also, in the future, it is planned to develop some other applications of smart cards in areas like healthcare and e-ticketing.

Ponder Yonder

To know more about Smart Card technology and Cryptography, visit:

1. www.smartcardbasics.com
2. www.wikipedia.org/wiki/Smart_card
3. www.cse.iitk.ac.in/~moona/scosta
4. http://web.cse.iitk.ac.in/~smartid/
5. http://en.wikipedia.org/wiki/Cryptography

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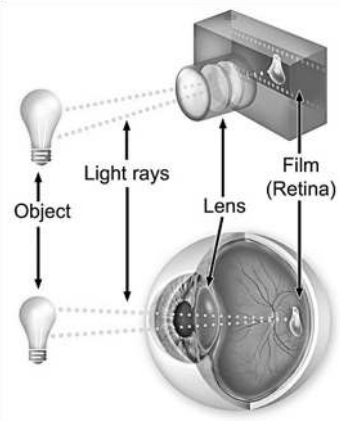
The lady in red

Award winning research from SURGE 2008

Vikas Trivedi

It had been seven hours, sitting crouched in the bus. The sun had just set and as the twilight was fading, gradually the image of bulbs inside appearing in the window glasses of the bus started interrupting our view of quiet and picturesque Himalayan hills. Away from the dust and haze of the plains to the transparent skies of Nainital, it was a heavenly experience to crawl through the forest. With dusk, the border between tops of trees and the overcast sky gradually became less distinct. The Naini Lake was glittering like a huge crimson metal sheet and I could still make out the golden letters with violet borders in the words "Kumaun University" as we slowly passed by it. Suddenly the bus came to a screeching halt near Khurpa Taal.



We peeped out of the window and saw a lady standing. It was quite dark. I could only surmise that she was of short stature with small probing eyes peeping through her oval glasses resting midway on the bridge of her nose, a mobile hanging from her neck, a purse by her shoulder dangling all the way down to her thighs and a mysterious smile on her face. She got on the bus. With short and swift steps in her golden red bordered 'nagra', she moved in and just she occupied a seat right behind me, an unknown, sudden feeling of security and happiness thrilled my body. I continued looking outside. The darkness had gradually embraced the place except our dimly lit bus crawling through the rugged mountain terrains. The bus stopped at 'Kanwal hotel' for the night stay. After dinner, I hung my hammock on the terrace, slid into the sleeping bag, pulled aside hammock's rain cover and idly viewed the darkening sky. Everything was in black and grey shades. While I was still trying to recognise constellations in the sky, I felt a small tender hand patting my head. I sprang up to realise that the hand was that of the same lady whose probing eyes and mysterious smile was still visible in the canopy of darkness that surrounded us.

She beckoned me to follow her to the edge of the terrace. To my astonishment, there was a Christian graveyard at the back of the hotel just a few steps from Malli Tal that was hazily visible. A stout old man with a harquebus was standing at the gate of graveyard. I could see him well but it appeared as

though he had to strain his eyes to see two people standing on the terrace of 'Kanwal Hotel'. "His vision is deteriorating", her soft voice broke the silence that was hovering the firmament a moment before. "The amazement that you have due to the strange disparity between the sights of day and night, your contrasting views of colourful meadows and dark night, your astonishment at the poor visionary power of this old man, all find reason in the make-up of our eyes" she continued in her calm and soothing voice as before but I was dumb-founded that how could she fathom what was in my mind!

"The eye of vertebrate animals is lined at back with retina. The portion of external world that is imaged on the retina depends upon direction in which the eyes are pointed. There are two types of photoreceptor cells in retina- cones and rods. Cones help in bright light or day vision and these were the ones that helped you see the colourful meadows and snow covered mountains. The other one i.e. rods empowered you to view the black and grey shades of darkness in the little light coming from distant stars because they are exquisitely sensitive and can detect a single photon. In animals that are diurnal, i.e. primates and birds of prey, and require ability to distinguish colours there is a specialised portion of retina called fovea, which is devoid of rods and hence called rod free zone or region of high acuity vision. It made you recognise the colours in the words "Kumaun University" and even the red borders of my 'nagra'". As she was speaking it seemed to me as if I was witnessing a mysterious revelation from a chiromancer who could apprehend all that was within me.

"This fovea, for reasons unknown", she sounded mysterious, "is susceptible to degeneration. Diseases like age-generated macular degeneration i.e. AMD appear to begin with loss of photoreceptors in the foveal region eventually leading to blindness. This is the reason why the graveyard guard has to strain his eyes to make out the details while we are quite comfortable looking at him with healthy, undeteriorated foveae. Despite considerable research being carried out in this field, the etiology of such diseases remains elusive. Characterising the molecular nature of fovea thus becomes imperative not only to understand why it is so susceptible to degeneration but also find clues to aid in designing effective therapy for such diseases."

Suddenly I woke up from my dream to realise that this was actually the problem statement of my SURGE 2008 project and that I have been transferred from the cold hotel terrace in Nainital to the heated L9 in IIT Kanpur to explain to everybody the work that I had done under the topic *"Molecular characterization of development of fovea in vertebrate retina".* I turned back and found that the mysterious lady whom I had seen a moment before was none other than my mentor Dr. Jonaki Sen who was again occupying a seat right behind me. Once again a sudden feeling of security and happiness thrilled my body that she was there, as always, to guide me and chuckling at having understood that I had just waken up from my day dreams. In a flash back I remembered what I had done.

I had been doing my experiments on chick (*Gallus gallus*) as it is an ideal model organism to study development of the fovea because it has a distinct fovea in retina. The gene encoding for Fibroblast growth factor 8 (Fgf8) was found to be expressed as a central spot and a horizontal line through the spot along the dorsal-ventral border of the retina at embryonic day 5.5 (Fig.1(b)) in the chick retina. This expression pattern mirrors the central rod-free zone (fovea) and horizontal rod-sparse stripe that develops in the retina at later stages (Fig.1(a)). The sequence of the Fgf8 coding region from the chicken, 500 base pairs of each of its flanking genes NPM3 and Fbxw4 (on the 5' and 3' end respectively) and the intergene sequence in between NPM3 and Fgf8 and Fbxw4 was analysed.

Do you know why?

When you step into bright light after being in a dark room, initially the light is blinding then slowly the eyes adapt.

Contact the author for the answer.

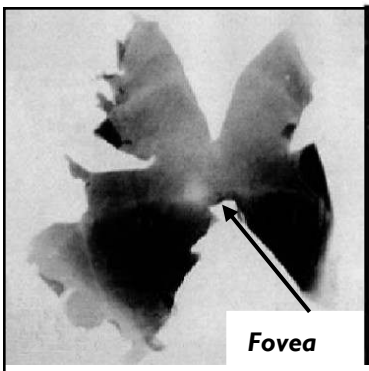


Fig1a):Fovea seen by rhodopsin staining in E18 chick retina

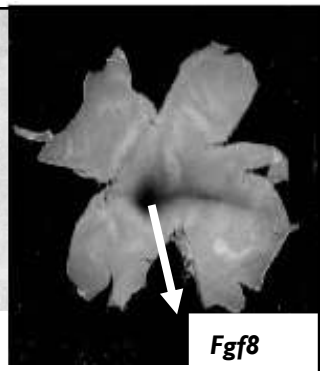


Fig1(b):Fgf8 expression at same place in E5.5 retina.

The region upstream of Fgf8 contains a 1,762 nucleotides long unsequenced region which we thought to contain a putative enhancer for the Fgf8 gene. More than 200 polymerase chain reactions were carried out to amplify, clone into Zero Blunt vector and sequence this region. The sequencing results at MWG, Bangalore indicates that the region may contain repetitive sequences.

The fovea first appeared in evolution in the fishes and then in birds. The fovea disappeared in primitive mammals, and reappeared in primates. The disappearance and reappearance of the fovea across several species correlates with gene functioning. Thus sequences alignments of the Fgf8 gene and intergenic regions between Fgf8 and the two nearest neighbouring genes on either side from different species could reveal evolutionarily conserved regions (ECRs) which may function as putative enhancers for Fgf8 (Fig 2(b)).

Enhancers are DNA sequences which regulate the expression of genes. There are protein molecules that bind to them and activate their effector gene. Working on this hypothesis I selected this region encompassing Fgf8 and its immediate neighbours from human (*Homo sapiens*), chicken (*Gallus gallus*), chimpanzee (*Pan troglodytes),* mouse (*Mus musculus*) and frog (*Xenopus tropicalis)* for comparison. Human, chicken and chimpanzee have well defined rod-free zones (foveae) but mouse, being a nocturnal animal does not have a fovea and the retina of a frog is very much like a human retina but has no fovea. Nucleotide sequence alignment revealed 4 regions that were present in vertebrates with fovea but absent in those lacking fovea (Fig. 2 (a)). These regions are 350, 1200, 327 and 388 base pairs long respectively.

Transcription factors (TFs) are proteins that regulate the expression of a gene by binding to DNA sequences that act as enhancers for these genes. These four ECRs were now investigated to find the TF binding sites (TFBS) and several of them were found. Thus far we have had some success in molecularly characterising the fovea. Future directions will be to find the cascade of reactions that govern the expression of Fgf8 and development of the fovea. In order to understand the exact nature and functions of the identified ECRs, an electroporation based strategy will be utilized to identify enhancer elements that regulate the precise expression pattern of Fgf8 in the central chick retina.

While it is clear that such expression pattern is very complex and multiple mechanisms are incorporated, it is evident that study of the molecular mechanisms involved and a closer look at the phenomenon, will no doubt open new horizons of neurobiology because in words of Gregor Eichele "What is perhaps the most intriguing question of all is whether the brain is powerful enough to solve the problem of its own creation. This very question will perhaps keep us searching for the answer".

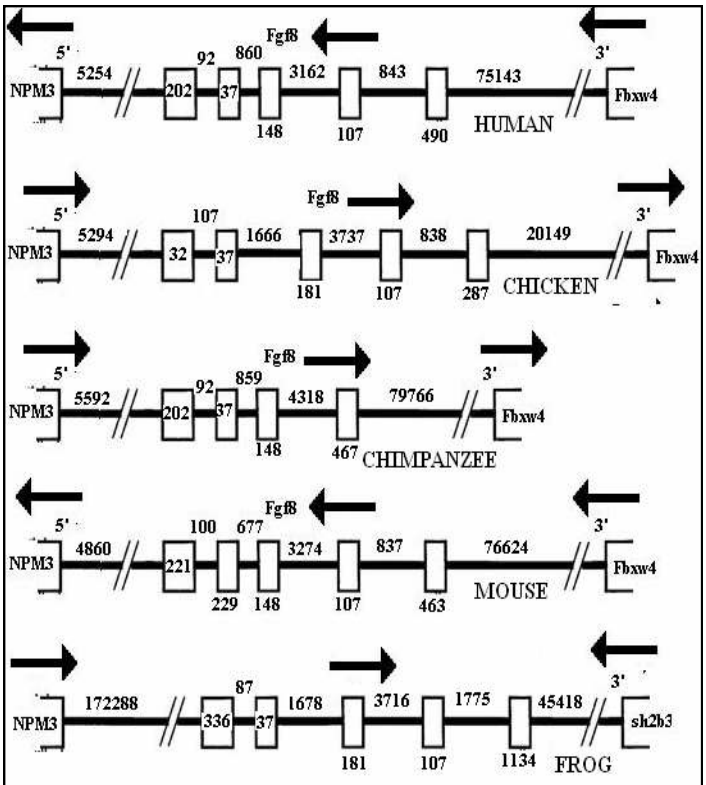


Fig2: Fgf8 gene with its flanking genes in 5 different species. Exons are shown by boxes (not to scale).

Vikas Trivedi (viktri@iitk.ac.in) is a third year undergraduate student in the Department of Biological Sciences and Bioengineering. His research interests include developmental neurobiology and biofluidics.

The poster presented on the work described in this article won second place in SURGE 2008.

Summer Undergraduate Research Grant for Excellence (SURGE) program is organized under an MOU with the highly acclaimed SURF (Summer Undergraduate Research Fellowship) of California Institute of Technology (USA) in which UG students take up focused research projects for a duration of 10 weeks (early May to end July) every year. For more details, log on to http://www.iitk.ac.in/surge.

GASE: Making India energy independent

Group on Alternative Sources of Energy

Rishabh Chauhan and Akshit S.

We live in the 21st century where development is necessary to sustain. The problem starts when this development starts endangering sustainability. We use natural resources as fuel, wood, coal et cetera for surviving, but do we give our time and effort to replenish them? Are they going to last long until replenished? No. Do you wish to run out of these resources one day? Again a no. There dangles the sword on our existence.

What is GASE ?

GASE (Group for Alternative Sources of Energy) is one such group of young thinkers who believe that possibilities can be turned into opportunities and opportunities into fully fledged goals. We believe that alternate sources of energy can alleviate our developing nation from several of its problems and make it shoot itself right amongst the top nations of the world. This belief is what brought us all together and is driving us to do whatever we can to make our fellowmen believe in what we believe to be true. Our world needs energy and energy as such needs dissemination. It has to be looked upon as a tool for progress and not as a social issue to be just blabbered upon. Ground level application of indigenously developed solutions for energy problems is what we are looking at in the near future and we have had a fair bit of experience at this in the past few months.

GASE group members at seminar on biogasifiers in Bangalore

The incubation period of GASE

The group is in its primary stage of operation. The summers 2008 saw the initial phase of work where we decided on certain objectives which had to be completed in the following weeks. We shortlisted certain alternative sources of producing energy on which work was being carried out in our campus or other institutes across the country, and identified some related workshops and seminars.

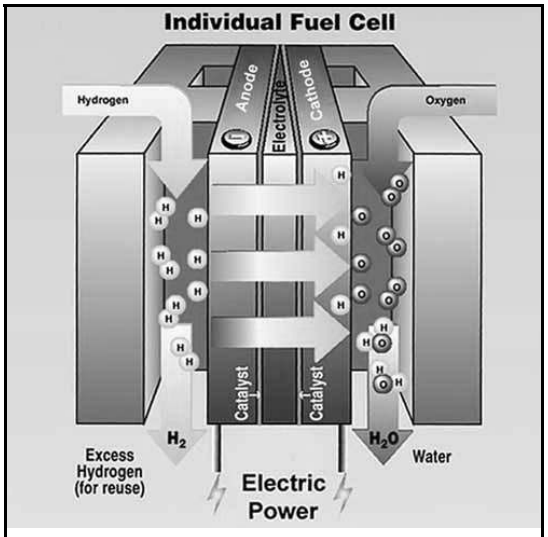
One such seminar was on the biogasifiers held in Bangalore and conducted by professors of Indian Institute of Science (IISc) Bangalore with the help of TERI (The Energy and Resources Institute). Strange! We were the only student group attending the seminar– all the other people were officials either from NGOs or government agencies and all aged above 35 years. Does it ring a bell in your mind? The youth which is believed to have the power to change the world is not even interested to save their future.

The group learnt about biogasifiers and the problems faced by NGOs at ground level– very less skilled workforce and the lack of technology dissemination. This little stint in Bangalore gave us enough motivation and confidence to start working towards our objectives.

The group met Dr. A. K. Shukla, Director, Central Electrochemical Research Institute (CECRI) located in Karaikudi, Tamil Nadu who came here to deliver the institute lecture on 'FUEL CELLS-Fueling Future Cars'. When he learned that a group of undergraduate students have started a group for development of alternate sources of energy, he invited us to CECRI, Karaikudi for some ground research work on fuel cells. He refined the goals of the group and gave a sharp focus on the use of fuel cells as sources of energy.

It is truly said that identifying a problem is the most difficult part, rest gets done easily. GASE members had a memorable trip to New Delhi during the

Dussehra holidays. We met Mr. Veerendra Kothari (BT/ME/1977/IITK) to discuss in detail about the energy efficiency project and their presentation on Nuclear Energy Economy presentation (mentioned later in the article). We also visited the RETREAT centre (an energy efficient building) built by TERI in Gurgaon to study its various innovative features, and the Solar Energy Centre (SEC) and IIT Delhi to observe the developments in the related fields and made many contacts who offered to guide the group.



Source: *US DOE, Office of Energy Efficiency and Renewable Energy*

Ongoing projects by GASE a

The group is presently working on four projects:

1. *Energy Efficiency*– The total electricity bill of IIT Kanpur last year was around Rs. 9 crores. The group believes it can be brought down. Charity begins at home. We started with studying minute details of the electricity wastage in student hostels and are working on providing an efficient way to reduce energy wastage, and harnessing the energy from waste materials. This is the most important project taken up by the group with an ultimate goal of an energy efficient campus.

2. *Solar Panel Installation*– The group is working under the guidance of Dr. Sameer Khandekar (ME) to set up solar panels and parabolic reflectors to harness solar energy within the campus, providing energy for a lab and to analyzing its efficiency. This will give hands on experience to the team involved in setting up a system and working on its various nuances. They have assembled the solar water heater, photovoltaic plates, and solar cooker using parabolic concentrator of TATA BP behind the Ac lab. The installation is complete and the functioning is estimated to start by the end of the year. Further plans include experiments on parabolic concentrator, to produce steam of temperature more than 250 degree Celsius and then using steam turbines to generate electricity, which has not yet been done in India.

Parabolic Reflector. ***Source:*** *http://solarcooking.wikia.com/wiki/Parabolic_reflectors*

3. *Fuel Cell Optimization*– We are working on optimizing the performance of fuel cell by studying various permutations and combinations of input parameters providing maximum output. A fuel cell generates electricity by reacting H^+ ions and O^{2-} ions giving H_2O as the only by product. It has fuel on the anode (i.e.H_2 gas) and an oxidant on the cathode (i.e.O_2 gas), which react in the presence of an electrolyte to give electricity. A proton-conducting polymer membrane (the electrolyte) separates the anode and cathode sides. The fuel cell to be worked on by the group is a PEM (poly ethylene membrane) with solid electrolyte.

4. *Rural Electrification through solar energy*- The group, under the guidance of Dr. S.S. K. Iyer (EE), is working on involving the setup of a stand-alone power generating solar PV system to provide energy to a school and a hostel, at a remote site in Orissa. The power requirement is estimated to be around 12-16 kWh but the group plans to setup a plant of around 40-50 kWh to fulfill the local needs of energy as well, or for supporting more buildings if the school grows in future. One of the most challenging projects faced by the group concerning the present situation of the state. We need to do the ground level work in real time conditions.

GASE and Indian Nuclear Power Program

The group made a presentation on 'Economic Aspects of Nuclear Power' before the Vice President Marketing of Areva (the world's biggest nuclear power company) Mr. Gerrard Ellia, delegates of BARC and members of the Indian Nuclear Society including high profile scientists from research, industry and academia, in the mini symposium on Indian Nuclear Power Program. The team members prepared an economic study of a power plant in a week (of which they knew nothing initially). The encouragement given by Mr. Veerendra Kothari and Dr. Prabhat Munshi (ME) helped us put up a highly professional show in the symposium.

Future endeavors of the group
Our future endeavors include:
1. Getting field projects from NGOs
2. Getting biomass related projects
3. Involving more and dedicated people in group's research

GASE has been recently renamed as GE3 (Group for Environment and Energy Engineering) with the ultimate aim of complete energy independence of the country, and is organizing a winter course on energy efficiency from December 10-13, 2008.

Rishabh Chauhan (crishabh@iitk.ac.in) is a second year undergraduate student in the Department of Materials and Metallurgical Engineering at IIT Kanpur. Akshit (askhits@iitk.ac.in) is a second year undergraduate student in the department of Electrical Engineering at IIT Kanpur. Contact them for any other details about GASE.

For more details about the winter course on energy efficiency by Mr. Veerendra Kothari, do not forget to go through the special issue of NERD (Vol. 1 No.3) in February'09.

Zonked!

1. Roads again
The natives of Roadland are at it again. Last time (thanks to some of you), they found out how many roads they can have. They have now upgraded their network so that their is exactly one path between any two cities in Roadland. They have moved onto the next level of urbanisation and now want X-Way outlets (these serve yummy yooters: very popular in Roadland). But as the are Roadlanders, they have their set of constraints. The X-Way mandarins would set up their supply stations in some of the Roadlandian cities, but they would oblige a city only if the maximum of its distance from all other Roadlandian cities is the least possible. At most how many supply centres can their be? Oh, I forgot to tell you that all Roadlandian roads mysteriously have the same length. (Yet again, this problem is based on a very simple and well known graph theoretical result)

2. 'Zor ka jhatka'
While sitting in a bus, the jerk experienced by a person sitting at the back seat is more than that experienced by a person sitting in front. Why?

3. 'Saagar kinare'
You must have seen a sea beach in films or may have been to one. Why do the waves break at the beach rather than in middle of the sea?

4. Peeling onions
You must have experienced tears in one's eyes if one is peeling and splicing onions. By what way can those tears be minimized? (You can't take the help of any other substance to answer it.)

Questions by Piyush Srivastava (piyushs@iitk.ac.in) and Dr. Anupam Pal (apal@iitk.ac.in)

Send in your answers at nerd@iitk.ac.in. The entry with minimum 3 correct answers will be awarded. Awards worth Rs. 1000 to be won!! Submit your answers latest by December 31, 2008.

For solutions of Zonked! In issue 1, please log on to http://www.nerdmag.org/.

ADDENDUM / ERRATA

(for NERD Vol. 1 No. 1)

It Happened Here: Bio-inspired Patterned Adhesives (Page 20): We missed out the name of Dr. Ashtosh Sharma (ashutos@iitk.ac.in) as co-guide for Abhijit Majumder (majumder@iitk.ac.in), the author. Apologies!

ATLAS SHRUGGED: Gluco-Band (Page 13): The proposed idea was actually thought by Manu Vajpai, Devika Garg and Deepak Ailani (all Y4 BSBE) as a part of the course under Dr. D.S. Katti (dsk@iitk.ac.in), and was later borrowed by and developed into a business plan by Vikram Pagaria, Rohitesh Gupta and Parag Surana, the authors. We duly acknowledge Manu, Devika, Deepak and Dr. Katti here.

Cyberpunk

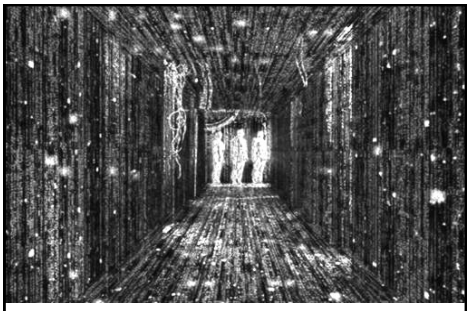
A Brand New Avenue for Interdisciplinary Research between Technology and Literature

Dr. T. Ravichandran and Adrene Freeda D'cruz

"Anything that can be done to a rat
can be done to a human being.
And we can do most anything to rats.
This is a hard thing to think about,
but it's the truth.
It won't go away because we cover our eyes.
That is cyberpunk."

Introduction

The above words from Bruce Sterling, a pioneering cyberpunk writer, represent the ethos of cyberpunk literature. Although the term is linked with literature because of its representations in fictional writings, it is closer to technology due to its affinity with super-computers, cyberspace and virtual/hyper reality. As technology, an indispensable part of human existence, radically alters the structure and fabric of our contemporary age, representations in the literary field closely capture the spirit of the techno-cultural society by documenting the man-machine interface. A perfect blending of literature and technology opens up space for an interdisciplinary approach within science-fiction termed as cyberpunk literature. Cyberpunk literature interacts with technology, and unfolds ways to understand the emerging new social order studded with technological details. Assimilating the cultural ethos of the age into literary representation, cyberpunk fiction explains a world enmeshed in technology.



Entering the Cyberspace (from the movie 'Matrix')

Cyberpunk – Etymology and Themes

Cyberpunk is a portmanteau word (a combination of two words) that fuses *cyber* in *cybernetics* with the sub-culture associated with the word *punk*. Bruce Bethke in a short story titled 'Cyberpunk' (1983) popularized the term widely. Etymologically speaking, *cybernetics* associated with control, derives from Greek *kybernetes* meaning steersman, governor, pilot. *Punk* on the other hand, takes its name from the anti-establishment rock music brands such as 'Ramones' and 'The Clash' which were conventionally marginalized as low art forms. The genre of cyberpunk dissolves the high/low categorization by merging with the mainstream representation in science fiction and foregrounds several themes associated with our everyday life. Some of the themes explored in cyberpunk literature include the creation of man-machine interface, the correlation between gender and science, and the production of counter culture in the technological sphere and a critique of unethical undertaking in cyber world.

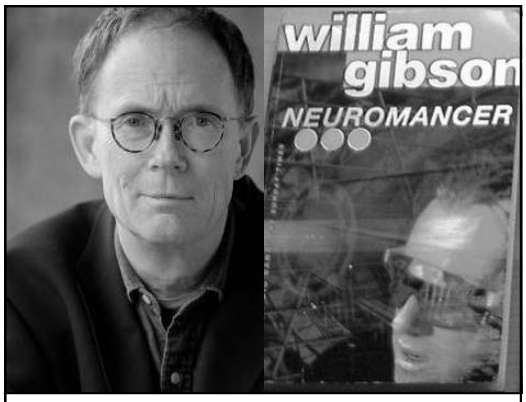
Fictional and filmic representations of Cyberpunk

Bruce Sterling's *Involution Ocean* (1977), William Gibson's *Neuromancer* (1984), Neal Stephenson's *Snow Crash* (1992), and John Shirley's *Silicon Embrace* (1996) are some of the representative pieces of fiction that articulate the salient features of cyberpunk literature. Besides, the film industry produces remarkable representations of cyberpunk literature on the screen. For instance Ridley Scott's *Blade Runner* (1982), Wachowski Brothers's *The Matrix Trilogy* (1999-2003), Steven Spielberg's Minority Report (2002), and Simon Wells's *The Time Machine* (2002) derive the raw materials for films mostly from literary works. Blade Runner and Minority Report are based on Philip K. Dick's novel 'Do Androids Dream of Electric Sheep?' (1968) and a short story titled *'Minority Report'* (1956). The Time Machine undoubtedly evokes the expertise of H.G. Wells in his 1895 science fiction by the same name.

William Gibson's Neuromancer (1984)

William Gibson's Neuromancer published in the Orwellian nightmarish year of "nineteen eighty-four," winning the triple crown of Science Fiction literary awards: the Hugo, the Nebula and the Philip K. Dick, immediately gained its status of a cult cyberpunk fiction and considered not only the first but also the best of its kind until now. Neuromancer is a full length experimental cyberpunk novel with Henry Dorsett Case, a hacker, as the protagonist. 'Cyberspace,' a neologism coined

by Gibson explains "a consensual hallucination experienced daily by billions of legitimate operators, in every nation, by children being taught mathematical concepts" (51). Case is mesmerized by the non-geographical virtual space simulated, manipulated, and regulated by the use of computer and the Internet. Theoretically speaking, the postmodern concept of simulation popularized by the French thinker Jean Baudrillard (1929-2007) aptly fits into the novel. For Baudrillard, simulation is a postmodern cultural phenomenon that refers to the way computers use a model to construct and reconstruct infinite number of models devoid of any original. In the absence of original, they function as signs which collectively constitute culture. Replete with technologically engineered human beings, the genre of cyberpunk characteristically documents a futuristic, punkish subculture. For instance, Ratz in Neuromancer, a bartender with prosthetic Russian arm and teeth built with East European steel, transforms customary ugliness into beauty. Also, Molly, a cyborg (*cybernetic organism*) with ten double-edged, four centimeter retractable scalpel blades housed beneath her finger nails has surgically implanted mirror shades which seal her eye sockets, and her head contains certain amount of silicon.



William Gibson and his 'Neuromancer'
*(**Source**: http://en.wikipedia.org/wiki/Cyberpunk*
http://www.collegecrier.com/interviews/images/WilliamG.jpg)

While depicting the mounting interface between man-machine created by the extensive use of computers and the Internet, Gibson's work does create a utopia for the computer geeks. Nonetheless, like Ridley's Scott's Blade Runner set in the future 2019 off world colony, Gibson chooses a dystopian future to indicate the unethical uses of cyberspace. The cyber-hallucinated individuals experience autonomy and freedom in the cyberspace, but the autonomy becomes a constructed concept and deludes human beings about their sense of independence inside the cyberspace. Although Case enjoys euphoric pleasure throughout his cyber voyage, he fails to realize that his autonomy is simulated and his identity is in question. Gibson is in favor of a technology that enriches the quality of human mind but foresees an Edenic fall (as represented through the life of the protagonist Case whose body is just a piece of meat) resulting from an unscrupulous use of technology. As the novel indicates, the genre of cyberpunk reveals the interface between technology and literature and also critiques the ill effects of cyber age, a world in which we live and play innocuously irreversible cyber games.

The name 'Neuromancer', being a variation on 'necromancer', a magician dealing in evil spirits and death, is more apt at present to indicate the Cybernetic Media Magician (the Charmer-Demon) gaining control over the nerves ('neuro'= nerves) of human beings and throws a dire warning against the ill effects of experiencing the cyberspace. The cyber age technologically produce an ultra-modern generation of cyborgs but ethically cause human cripples struggling to survive in a world that is inherently callous, cruel, and corrupt.

Cyberpunk and Postmodernism

It is problematic to attempt a singular definition for the umbrella term, postmodernism. Simplifying to the extreme, postmodernism can be understood as a socio-cultural phenomenon in various fields including literature, painting, technology, architecture dominating the second half of the twentieth century. Postmodern fiction including cyberpunk literature, grapples with a media driven society produced by the rapid growth in information technology. It foregrounds the fragmented identity of the individuals inhabiting a technological sphere, and examines the media saturated environments legitimizing multiple viewpoints on the same event.

Technology and significant novels of Don DeLillo

Known as an exponential figure in postmodern circles, the American novelist Don DeLillo (1936-) deals with the various issues vexing contemporary media driven society. DeLillo's *White Noise* (1985), the National book award winning novel, explores the consumer culture that seeped a town named Blacksmith. The town, where the protagonist Jack Gladney, his wife Babette and their children barely managed to survive, is a microcosm of urban decay (brought out frequently with reference to rats), a sphere of virtual reality (lives entangled in computerized codes and messages) and a cultural matrix of capitalism (space occupied by the abundance of

canned food, supermarkets, obese adults/children).

Besides, the novel subtly critiques the degradation of environment due to excessive exposure to toxic waste (ecocide). Although technological growth offered life comfort, it created adverse effect on ecology and humanity. In such an age, the glorious sunsets, typically embodied in rich romantic imagery, have become an unbearable sight described as *the sun going down like a ship in a burning sea*. They also illustrate an age where television bombards the characters with excess information, creates undue adulation for celebrities, and tricks the consumers using advertisements.

In addition, the novel captures myriad concerns of consumer capitalism in the title White Noise. Technically speaking, white noise in its infinite bandwidth—like white light containing all the colors in the spectrum—includes sounds at all frequencies. The concept of 'white noise' is given a metaphorical twist that has many implications. Babette in White Noise brings out the significance of 'white' in her life by associating it with death. Babette is a scapegoat of the capitalist enterprise as she is made to believe that consuming a pill named 'Dylar' she can escape death. Dylar is described as a 'white' tablet that signifies death because its consumption leads to loss of memory and eventual death. Also significant is the association of the 'noise' being 'white'. There is an implication of cacophony as opposed to euphony (noise as opposed to musical sound) made by the people lost among dazzling hedgerows inside supermarkets. As the insignia of consumerism, supermarkets are copies without original since all the products are mass produced, in likeness and image, into plain 'white' packages with simple labeling. Caught in the nexus of consumer culture, people blindly devour objects following advertisements on television. In short, White Noise deals with the issue of ecocide, the ill effects of technological boom and the construction of truth through simulated media images such as advertisements.

Representation of Clones, Simulation, Simulacra, and the hyper real

DeLillo in *Libra* (1988) takes up an historical event, the assassination of the American president John F. Kennedy, and gives it a fictional twist. The media create a successful coverage of the events leading to assassination, while history documents the event using a 'lone gun man theory.' The lone gun man theory has it that Lee Harvey Oswald shot Kennedy from the thirteenth floor of Texas School Book Depository in Dallas. But in the novel, DeLillo unravels the different conspiracy theories that made Oswald a scapegoat in history. The word *conspiracy* in itself has a Latin root meaning *breathing together*. In conspiracy theory, the distinction between law makers and law breakers blurs. For instance, the fictional representation of the assassination turns the FBI official Guy Banister and members of the John Birch Society (with an anti-communist agenda favoring McCarthyism and against Kennedy's peace polices with USSR) into accomplices in the plot to kill the president. The representation by media offers one truth (positioning Oswald as the assassin) but this truth is partial since it is constructed, and novelists like DeLillo utilize the excess of truth (by analyzing the role of bureaucracy, the part played by Oswald's mother, wife and also Jacky Ruby who killed Oswald) to threaten a stable structure.

Invalidating monolithic truth is one of the abiding concerns in postmodernism, and DeLillo delegitimizes inflexible truth claims in his recent novel titled *Falling Man* (2007). The annals of history document the event, the 9/11 attacks on the World Trade Centre, with utmost importance. DeLillo in Falling Man strips the event off its historical accuracy by recreating it from several perspectives. The title Falling Man alludes to Richard Drew, an influential member of the American News Agency Associated Press, who became famous with the photograph of the falling man from the Twin Towers on September 11, 2001. Formerly, the photograph was titled 'Jumpers' but Tom Junod in the September 2003 issue of Esquire magazine translated the pictographic image into an article entitled '*Falling Man.*'

The literary recreation in DeLillo's *Falling Man* shows how events such as these create an unquenchable desire in the minds of the audience to view it endlessly. The desire to view and re-view the events creates more and more surplus desire to see the event infinitely. The event triggers its recreation in all possible modes of representation.

It is represented through the art of performance (David Janick), through writing (Lianne and the Alzheimer's patients), visual media (computers and television), binoculars (Katie, Robert, Justin), and painting (art dealer Martin Ridnour). The electronic images flashing on television bring in excess perspectives in other modes of representation (one being the novel itself) transgressing the idea of singular representation and truth value of events.

Research Potential

Literary representation in postmodern novels and cyberpunk literature foregrounding a society immersed in media images holds ample potential for research. Technology with its merits and demerits becomes an efficient tool for novelists to scrutinize contemporary society. Making use of technology as tool for analyzing present culture, the novelist brings out the ideological implications of how truths are constructed using electronic medium. The novels shed light on the happenings in our own society, help readers think from different standpoints, and inform us about the pros and cons of the technological explosion. Thus, cyberpunk literature offers plentiful capacity for research in studying the interface between literature and technology; man and machine; cyberspace and hyper reality; utopia and dystopia; identity conflicts; professional ethics and human values.

Ponder Yonder

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Dr. T. Ravichandran (trc@iitk.ac.in) is an Associate Professor of English, Department of Humanities and Social Sciences, IIT Kanpur. His research areas include postmodern novels/science fiction, cyberpunk literature.

Ms Adrene Freeda D'cruz (adrenefd@iitk.ac.in) is one of the six Ph. D. research scholars working under the supervision of Dr. T. Ravichandran. Her area of specialisation is postmodern American fiction . She is working exclusively on the topic "Modes of Excess in Don DeLillo's Novels".

S– Cube

***S-CUBE**, the Post Graduate **S**tudent **S**eminar **S**eries* of Department of Biological Sciences and Bioengineering (BSBE), is a platform to discuss current global research scenario in the broad area of Biological Sciences and Bioengineering. Through S-CUBE we make an attempt to get acquainted with emerging concepts and questions that boggle the minds of scientific community world-wide. We are also informed of the technical advances achieved to tackle some of these issues. Source of this information is recent research publications in the field.

This seminar series is part of the PG-course curriculum. Second Year PG students of the department select research papers to be presented. The presentation is half-an-hour long followed by 15 minutes question and discussion session. The latter session proves really helpful in getting an insight into the logical reasoning needed for doing science and engineering. Our faculty members motivate students towards critical discussion and provide direction to the same end by their active participation.

This keeps us up-to-date on the research areas we pursue as well as gives us a glimpse of happenings in other related areas of Biological Sciences and Bioengineering. Moreover, this also helps the student community in learning the art of reading and presenting scientific work.

At the end of the day one goes back enriched with new ideas, alarmed of flaws and shortcomings to be avoided in science and many times new perspective towards an old knowledge.

Mr. Varun Bhaskar (varunrsb@iitk.ac.in) and Ms. Priti (pritii@iitk.ac.in) are the student coordinators of S-cube. The faculty coordinator is Dr. Amitabha Bandopadhyaya (abandopa@iitk.ac.in).

ATLAS SHRUGGED: Re-creating the Big Bang

Interview with Dr. S. Raychaudhari about Indian contribution in LHC

Parul Singh and Sambhav Karnawat

One "Ring" to rule them all,
one "Ring" to find them,
One "Ring" to bring them all
and in the darkness bind them…
(From Lord Of the Rings- The Fellowship of the Ring)

What is the Large Hadron Collider?

The Large Hadron Collider (LHC) is the world's largest particle accelerator. Built underground in the Geneva valley near the Swiss and French Alps, it is touted as the biggest and the most complicated Physics experiment ever. The LHC is exactly what its name suggests: a large collider of hadrons (specifically protons); and this machine deserves the label 'large' – it not only weighs more than 38,000 tons, but also runs for 27 km in a circular tunnel 100 meters underground, and involves nine billion dollars.

The LHC will accelerate particles to the highest energies ever generated (7 TeV), colliding them head-on millions of times a second, with each collision spraying out thousands of particles at very nearly the speed of light. When the machine is running at its full power, nearly 3000 bunches each containing up to 100 billion protons could be hurtling around in each direction, producing more than half a billion collisions every second. Picking through the spewed debris, scientists hope to discover traces of previously unseen particles theoretically predicted to exist or even more exotic entities such as black holes and extra dimensions. One of the early targets will be the long-sought and much-discussed Higgs boson – the capstone of the Standard Model of elementary particle physics. Interaction with a sea of normally-invisible Higgs bosons is thought to imbue all elementary particles with their intrinsic masses.

September 10, 2008: A historic moment in the CERN Control Centre: the beam was successfully steered around the accelerator. *(Source: http://press.web.cern.ch/press/PressReleases/Releases2008/PR08.08E.html)*

The mammoth machine, after a nine-year construction period overcoming various unforeseen difficulties, started to begin producing its beams of particles this year. The first beam was steered successfully in the LHC at the world's leading laboratory for particle physics- *CERN (European Organization for Nuclear Research)* on September 10, 2008. More than 8,000 scientists, engineers and students from 111 nations are collaborating on the gargantuan effort. It was officially inaugurated on October 21, 2008.

Why LHC anyway?

The LHC is to physics what the Apollo program was to space exploration. It is a massive technological enterprise that promises to open up new vistas on our understanding of the Universe. The secrets of dark matter, the mysteries of the so-called '*God particle*', and extra dimensions of space-time are just a few of the exotic discoveries that the scientists are hoping to make with the LHC. The collisions at LHC could spray out strange new kinds of matter, unfurl hidden dimensions of space, and even generate tiny glowing re-enactments of the birth of the Universe. In short, there is more than just the search for the Higgs boson going on at the LHC.

"We don't even know what to expect," says French physicist Yves Schutz. "We're now in a domain of energy that nobody has ever explored." For almost a decade now, particle physicists have been eagerly awaiting a chance to explore the Tera-scale energies. It has been a long, long wait. During the intervening years, particle theory has leapt far beyond experiment, to unattainable energy levels and correspondingly tiny distances. Significant new physics is expected to occur at these energies. It is hoped that this experiment will help bring particle physics back to its experimental roots.

How it works?

The LHC is mainly based on proton–proton collisions. Prior to being injected into the main ring, the particles are accelerated by a series of systems that successively increase their energy. Most of these systems have been used in the past for front-line research and are being re-used to boost the energy to the LHC level. Hydrogen atoms are stripped of their electrons, yielding a bunch of protons which are first injected into the linear accelerator (LINAC 2) generating 50 MeV protons.

LINAC 2 feeds the Proton Synchrotron Booster (PSB) which accelerates the protons up to 1.4 GeV, followed by the Proton Synchrotron (PS) where the energy is upped to 26 GeV. Finally the Super Proton Synchrotron (SPS) is used to further increase their energy to 450 GeV before finally reaching the Large Hadron Collider (LHC). The LHC accelerates the two beams of 'hadrons' in opposite direction around the 27 km accelerator upping their energy in every lap. When the beams reach their maximum energy, LHC allows them to collide at four points along the circular journey. There will be 600 million particle collisions per second, and although the particles themselves are mere specks—less than a million millionth the size of a midge—their collective energy will be that of an express train. Once set in motion, a stream of particles might circulate for 10 hours before needing to be refreshed.

Dr. S. Raychaudhari

Keeping these high energy particles on track requires serious bending power. More than 1,200 superconducting dipole magnets are used to guide the particles on their circular paths. Additional 392 quadrupole magnets are used to keep the beams focused, in order to maximize the chances of interaction between the particles in the four intersection points, where the two beams will cross. In total, over 1,600 of these magnets, each of which weighs several tons a piece, must be kept at an operational temperature of 1.9 K (colder than the void between galaxies) requiring CERN to build the world's biggest cryogenic system to handle the 700,000 litres of liquid He that will be used to chill the magnets.

However, the collider is only one of three essential parts of the LHC project. The other two are the detectors sitting in 4 huge chambers at points around the LHC channels and the GRID (a global network of computers and software essential to processing the data recorded by LHC's detectors).

Indian contribution in LHC

India had active participation in two of the four major experiments at LHC conducted by CERN. Indian laboratories, led by *Raja Ramanna Centre for Advanced Technology (RRCAT) at Indore*, have contributed substantially towards construction of the accelerator (LHC) itself, with many components being fabricated by Indian industry and supplied to CERN.

NERD team had an exclusive interview with *Dr. S. Raychaudhari*, Associate Professor, Department of Theoretical Physics, Tata Institute of Fundamental Research (TIFR) Mumbai. He was a faculty member in the Department of Physics, IIT Kanpur from 1999 to 2007. Being a theoretical high energy physicist, his chief interest lies in phenomenological studies of physics beyond the Standard Model of elementary interactions. Currently, he is working mostly on predicting experimental signatures for theories such as electroweak interactions, supersymmetry and low-scale quantum gravity, especially in the context of high-energy colliding-beam machines.

He elaborated on the Indian contribution in LHC and the state of present cutting-edge research and development in India on linear and other accelerators. Here are some of the excerpts from his interview:

NERD: You have been working on the interface of theory and experiment in the area of High Energy Physics. What do you feel has been your most important contribution to the scientific community?
Dr. Raychaudhari: I do feel that one of the important contributions which has been made by me and some of my contemporaries is to make this interface area respectable in the eyes of the Indian scientific community. Somehow, in our country, a generation ago, there was an unwritten hierarchy in the type of research done. If it was very mathematical (like general relativity, cosmology et cetera), it was considered first rate (irrespective of what was actually done); if it involved computation, it was considered mediocre. Experimental work was considered fit only for the bottom rank of students.

When students with good academic records (myself, among others) quit other career options and chose to work in this interface region, at least some people began to accept that there are challenges in every area. Subsequently, many Indian students with brilliant academic records

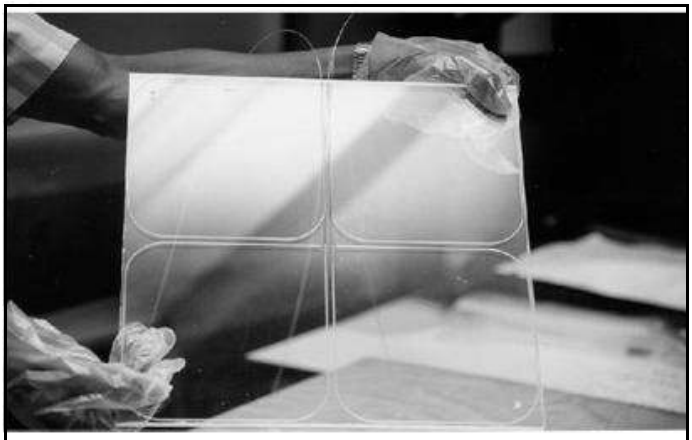
have started working in this subject. Alas! Very few of them are from IITs.

On a personal note, I think I have been a pioneer in bringing particle physics of extra dimensions to India. Such theories have now gained notoriety by predicting the production of black holes by LHC. Not only was I among the first few authors to publish on this subject, my talks at various forums between 1999 to 2002 played a major role in waking up the Indian scientific community to this exciting aspect of elementary particle theory. I am still the first choice when it comes to selecting an Indian speaker to review this topic.

Dr. S. Raychaudhari has been a pioneer in bringing particle physics of extra dimensions to India.

NERD: You gave a talk in 2003 in 6th ACFA (Asian Committee for Future Accelerators) meeting on linear colliders at TIFR on Indian contribution in extra dimensions. What is the state of present cutting-edge research and development in India on linear and other accelerators?

Dr. Raychaudhari: As you know, India is still a developing country and there is no way in which we can financially afford to build a large accelerator facility as the US, the EC and Japan have done. However, there has always been Indian participation in large international collaborations. For the LHC alone, the Government of India has committed US $ 25 million (around Rs. 120 crores at current exchange rates) to be paid in hardware and manpower.



A scintillator tile placed in the Hadron Calorimeter of CMS (Compact Muon Solenoid) was developed in TIFR/BARC labs in India

Earlier there has been participation by TIFR and BARC in the LEP (Large Electron-Positron Collider) experiment at CERN, Geneva, the D0 experiment at Fermilab, Chicago and the BELLE experiment at Tsukuba, Japan. The last two are still going on. India has been one of the pioneers in proposing the International Linear Collider (ILC) and some of the early R&D for this has been and is being done in India. I happen to be a member of the Indian Linear Collider Working Group (ILCWG) led by Professor Atul Gurtu (TIFR) and Professor Rohini Godbole (IISc). In this capacity, I have organized working groups on physics analysis in international conferences at Seoul, Paris, Stanford, Bangalore and Hamburg.

Though you have mentioned accelerators in particular, it would be unfair not to mention the major effort which is going into setting up the Indian Neutrino Observatory (INO), a TIFR project which is about to start in the Nilgiri hills near Ooty, under the leadership of Prof. Naba Kumar Mondal. As INO will specifically study neutrinos, I am not directly involved in the project, but, of course, the physics is interlinked with that of the LHC and other accelerators.

NERD: LHC is an international research project, and we have been hearing that you moved to TIFR to be a part of this project. In which part of the experiment, are you and TIFR involved specifically?

Dr. Raychaudhari: This is not quite correct. I moved to TIFR primarily so that I can devote my full time to research, which was not possible at IIT Kanpur, given the necessity of teaching 1½ courses per semester, grading six examinations a year et cetera. The fact that TIFR has a large experimental group involved in LHC studies was an added attraction.

I am a theorist, which means that I do not carry out the actual data analysis. There is an experimental group in TIFR who do this kind of work, and I interact closely with them to discuss details of the experimental setup, experimental errors, detector limitations et cetera. My actual work is concerned with the next stage of the analysis.

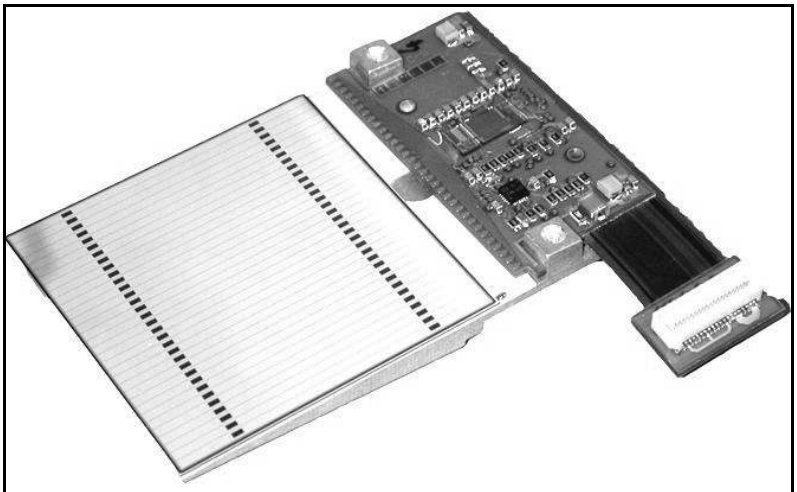
For example, a typical experimental signal at the LHC may consist of an electron-positron pair, a couple of hadronic jets and imbalance in the momentum of the final states. Suppose, now, that the direct analysis of data at the LHC shows, say, a 5% excess in this kind of signal over the predictions

understand how this excess can be explained in theories which go beyond the Standard Model, for example, theories with supersymmetry or extra dimensions. Especially, if one or more different theories can predict the same 5% excess, my interest would be in looking for additional characteristics of the signal (e.g. the angular distribution of the scattered electrons) which could be used to distinguish one theory from the other. Matters are not quite as simple as I am making it sound, but you get the gist.

NERD: How are other High Energy Physics centers in India, such as Institute of Physics (IOP), Physics Research Laboratory (PRL), Saha Institute of Nuclear Physics (SINP) et cetera involved in this LHC project?

Dr. Raychaudhari: Here are some highlights of Indian participation in the LHC:

1. Many of the bending and focusing magnets at the LHC – which have to be manufactured to very high precision parameters – were fabricated at the RRCAT in Indore. At the RRCAT, they have made two small accelerators, the INDUS-1 and INDUS-2 machines, which are used for testing purposes.



Silicon Strip Detector used for gamma ray identification in the LHC project was made in TIFR/BARC labs in India.

2. The core of the CMS (Compact Muon Solenoid) detector, one of the two giant detectors at the LHC, involves a tracker which requires a very sophisticated software package to identify different particles going through it. One of the leaders of the team which wrote this software was Professor Sunanda Banerjee of TIFR. Though Prof. Banerjee has recently moved to the USA, all the work was done while he was in TIFR.

3. Another part of the CMS detector, the hadron calorimeter, has a portion called the tail-catcher, where particles which have been missed by the rest of the detectors will be detected. A large part of this was fabricated in the laboratories at TIFR and BARC If supersymmetry is found at the LHC, this part will play a crucial role in identifying it.

4. Scientists from TIFR, BARC, Delhi University, Punjab University and the University of Rajasthan at Jaipur are involved in the computer simulation and analysis of data from the LHC, when it becomes available. Some of these analysis codes have been developed in India, especially in TIFR and BARC.

5.A team from Saha Institute of Nuclear Physics (SINP), Kolkata is involved in the heavy ion project of LHC.

6.Harish-Chandra Research Institute (HRI) at Allahabad, has started a centre called the Regional Centre for Accelerator-based Particle Physics (RECAPP), which is devoted mostly to promoting LHC studies in the north Indian region through conferences, workshops and interaction meetings. The RECAPP also provides facilities for large-scale computation to its associates in this region.

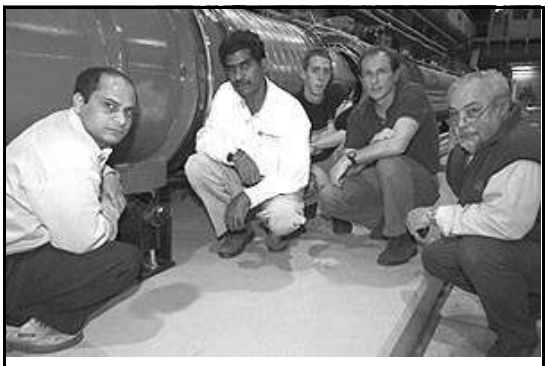
Overall, I feel that Indian participation in a project as large and as important as the LHC is nowhere near what it should be. If startling new results come out of the LHC, we may then wake up as a community, but then it will be too late.

NERD: It was in news that LHC experiment has been temporarily shut down till spring 2009 due to liquid helium leakage. What are the effects of He leakage on the project?

Dr. Raychaudhari: Even if you buy a new toaster, you may find that when you test it, a knob comes off. Stick it back with superglue and it will last for years. The helium leakage is just such a teething problem in an enterprise of this size, and all that has happened is that it has caused a delay. Be prepared for more such glitches. Not only does the LHC stretch the limits of known physics, but also the limits of known technology. But I am sure that it will run, and once it runs, it will be no less a wonder of the world than the Taj Mahal or the Great Pyramid.

NERD: Stephen Hawking had bet that Higgs Boson shall not be found in this LHC experiment. What are your views on it?

Dr. Raychaudhari: A great scientist like Professor Hawking is entitled to have his own views, but every single piece of indirect evidence that we have today is simply screaming at us to say the Higgs Boson exists. I would therefore place my money on the Higgs boson being found, or an object very similar in properties to the Higgs boson being found.



Eight hundred supports for the large 32-tonne LHC main magnets are delivered from India. ***Source:*** *http://lhc-milestones.web.cern.ch/lhc-milestones/year2003-4-en.html*

NERD: What is your final message to the students?

Dr. Raychaudhari: What is there to say? The facts speak for themselves. We live in exciting times, and maybe you will see our knowledge of the microscopic world undergoing another revolution as it happened in the early part of the twentieth century when relativity and quantum mechanics were discovered. I would like to invite more bright minds to this intellectual feast. I would also like to see young Indian minds wanting to take up challenges, irrespective of guarantees of success. We have the brain power -- loads of it -- but without matching enthusiasm, ideals and courage, we can never take our proper place in the community of nations. So even if you are going to join a banking or software multinational next week, do encourage your little brother or sister, or the child growing up next door, to become a scientist and a seeker after the Truth.

"If you are going to join a software multinational next week, do encourage your little brother to become a scientist and a seeker after the Truth."

The next BIG THING…

The LHC is still new, but its successor - the ILC (International Linear Collider) – is already being discussed. So why are the scientists planning to build two high energy colliders working on similar principles?

The LHC is a 'discovery' machine, a general purpose tool that will open up new areas of physics and demonstrate the existence, or not, of predicted new laws and particles. The ILC is a precision instrument that will allow scientists to explore in detail the discoveries made by the LHC.

The ILC is still at the planning stage- no location for the machine has been agreed and much feasibility testing has to be conducted before the construction phase. For more details, see : http://en.wikipedia.org/wiki/International_Linear_Collider

Glossary

Collider*:* An accelerator in which two beam of particles travel in opposite directions and collide head-on.

Higgs Boson: A hypothetical elementary particle predicted by the standard model; a boson (mediator or force carrier of the weak force) with zero spin, it is thought to give mass to other particles.

Hadrons: Subatomic particles that are composed of quarks. Hadrons are held together by the strong force, similarly to how atoms are held together by the electromagnetic force. There are two subsets of hadrons: baryons and mesons; the most well known baryons are protons and neutrons.

Supersymmetry: A hypothetical *symmetry* relating particles of different spins. Under this symmetry, matter particles (spin one-half fermions) are related to force particles (spin-zero or spin-one bosons).

Standard Model*:* A model of six quarks and six leptons as fundamental entities, as well as the 3 mediating force carriers, or vector bosons.

Ponder Yonder

The complete version of this article can be found at NERD site- http://www.iitk.ac.in/nerd. The following web addresses were majorly used for the article:

1. *http://public.web.cern.ch/*
2. *http://www.lhc.ac.uk/*
3. *http://lhc.web.cern.ch/lhc/*

Various Indian newspapers and magazines also helped writing it.

Parul Singh (paruls@iitk.ac.in) is a second year undergraduate student in the Department of Aerospace Engineering at IIT Kanpur. She is interested in physics and programming.

Guns and Lasers

Micro structure engineering using Laser surface treatment

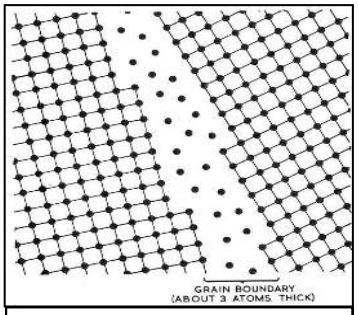
Gaurav Mishra

Introduction

Given a metal or alloy, is it possible to change the material properties by shooting little iron balls (this process Shot Blasting in Material engineering) on the material followed by some treatment with lasers (Laser Surface Heating)? This short report presents the work on observing the change of properties of *stainless steel* by combining shot blasting with laser surface heating.

Fundamentals

Most of the engineering materials are poly-crystalline in nature. When a liquid metal is cooled from molten state, its solidification involves nucleation of solid crystals at various places inside the liquid metal. Different crystals grow in different crystallographic directions. When the growing grains meet each other their growth is obstructed and a *grain-boundary* (GB) forms there. Grain- boundaries (GBs) have less efficient packing i.e. a more disordered structure, higher energy and faster transportation as compared to the grains.



Grain boundary structure

Intra-granular Corrosion in Stainless Steels

Stainless steel (SS) finds immense and varied applications from our households to industries. Chromium (Cr) is the alloying element responsible for its stainless properties. SS does not stain or corrode at room temperatures, but in industries where formed austenitic SS components are subjected to higher temperatures (say 500° – 800° C), they undergo corrosion owing to a phenomena called *Sensitization*, which involves depletion in chromium content of regions around the grain boundaries leading to *inter-granular corrosion* (henceforth referred as IGC).

Sensitization involves precipitation of $Cr_{23}C_6$ (chromium carbide) at the grain boundaries leading to Cr-depletion in the adjoining regions. Cr-depleted zones, being anodic with respect to grain interior, are preferentially attacked in a corrosive environment thus resulting in IGC.

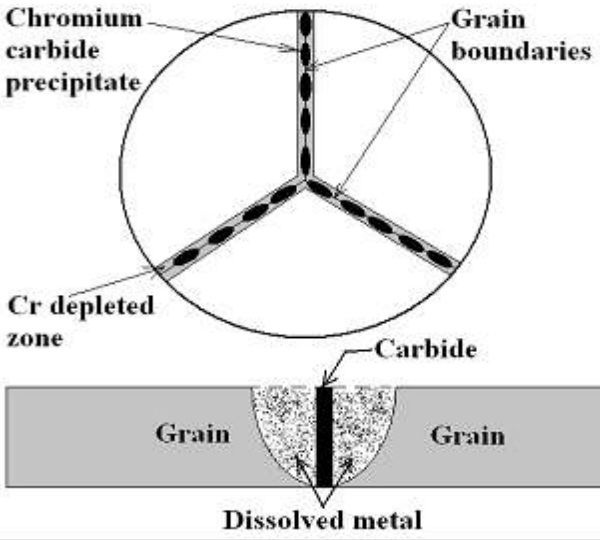
Control of Sensitization and IGC

IGC is a highly deleterious and undesirable thing to happen in high-temperature application SS components. We have to devise means to control sensitization- *developing an IGC-resistant microstructure.* Some engineering strategies that have been used for controlling sensitization and hence IGC are:

1. *(Extra low C grades)* Lowering Carbon content below 0.03% - Low Carbon content does not permit sufficient carbide to form to cause IGC in most applications. Example: Type 304L SS, 316L SS etc.
2. *(Stabilized grades)* Addition of elements with strong affinity for C -Ti, Nb, Ta

These elements combine with most of the C to form uniformly distributed carbides in the matrix. Example: Type 321 SS, 347 SS.

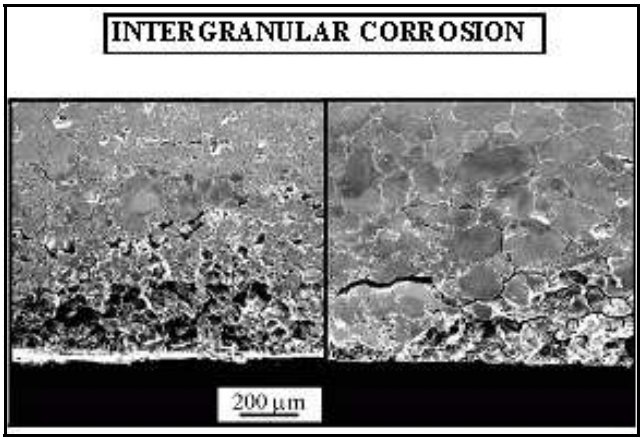
However an alternative cost-effective approach to the problem is *evolution of IGC-resistant microstructure.* This involves grain boundary engineering thus modifying the microstructure suitably.



Schematic representation of grain boundaries and IGC in sensitized austenitic SS

Approach for evolving resistant microstructure

Recent research has shown that precipitation of $Cr_{23}C_6$ preferentially takes place on *high energy grain boundaries.* So, the basic approach towards engineering the microstructure would be *to increase the volume fraction of low-energy grain boundaries***.** This reduces the high energy grain boundary density thereby reducing the possible sites of sensitization, and enhances material's resistance against sensitization. The point that needs to be emphasized here is that almost all the work reported till date for engineering IGC resistant microstructure relies on thermo-mechanical treatment (TMT) to control grain boundary character distribution (GBCD). This approach involves cold working followed by heat-treatment to cause re-crystallization, which results in the formation of strain free grains and hence reduces the energy of grain boundaries**.** The new microstructure thus contains higher volume fraction of low energy grain boundaries. However, conventional TMT cannot be applied on formed components.



A New Hope

In order to extend microstructure engineering to formed components *we attempted to devise an alternative method. We combined conventional shot-blasting with laser surface heating to effect Recrystallization.* This was a novel approach in itself with a unique advantage of being applicable on formed components which is not possible with the conventional approaches used to effect Re-crystallization. Re-crystallization basically involves formation of a brand new packing order resulting in the formation of strain free grains by nucleation and growth process.

The present work aimed to combine conventional shot blasting and laser surface heating to effect solid-state surface re-crystallization for modifying GBCD. *This is a new approach of micro-structural engineering which has not been investigated elsewhere.* A significant advantage of adopting this approach is that it can be applied on a formed component which is not possible with TMT-approach.

Process

Shot blasting involves striking the austenitic SS components' surface with high speed steel shots to cause grains to undergo strain (cold working). After cold-working, laser treatment is done on the surface which allows the stored strain energy to be released by formation of new strain free grains. Formation of strain free grains means that the Cr depleted zones around the grain boundaries are dissolved resulting in uniform Cr concentration throughout. This greatly improves the resistance to IGC.

After treatments, we basically performed three tests on the samples:

1. X-Ray diffraction analysis to identify the phases nucleated after the process;
2. Metallography to observe the shot blasting effect, recrystallized grains et cetera; and
3. Micro-hardness measurements to compare the hardness of recrystallized surface with that of the original sample.

These tests were carried out on various 304 SS samples like: as received 304 SS; sensitized 304 SS, laser welded 304 SS joints and 304 SS with a weld deposit of 308 SS. The reason why 304 SS and 308 SS were chosen for this study is that these stainless steels are the ones that are used in making components for Particle Accelerators and *Raja Ramanna Center for Advanced Technology (RRCAT),* Indore, where the work was done, specializes in development of Particle Accelerators. The idea was to utilize the results of the study on accelerator development from a materials viewpoint and hence the choice of the steels. A variety of samples (as received, sensitized, laser welded et cetera) used to span the general state in which stainless steel is normally present in components. Details of individual test results have been skipped but the final results have been summarized below.

Results and Conclusions

In the light of results obtained during the course of experimental study, following conclusions were drawn:

1. Solid-state hybrid surface treatment, involving hot blasting and laser surface heating, was successful in yielding fine re-crystallized surface structure in type 304 SS, in as-received condition.
2. In the case of sensitized type 304 SS, hybrid surface treatment did result in surface re-crystallization, accompanied by partial dissolution of carbides and partial erasing of original grain boundaries. However, the process needs to be optimized to obtain uniform effect across the treated surface.
3. No surface re-crystallization could be generated in laser welded type 304 SS specimens and type 308 SS weld deposit.

Further work in underway at RRCAT, Indore to perfect and optimize this process for prevention of IGC in Stainless Steel components. The author wished to acknowledge the guidance he received from Mr. Rakesh Kaul, Scientific Officer at RRCAT for carrying out this work.

Gaurav Mishra is an IIT Kanpur alumnus of the Class of 2008 from the Materials and Metallurgical Engineering Department. This brief semi-technical report is a result of the work he did during summer 2007 at Raja Ramanna Center for Advanced Technology, one of the research centers of ***DAE (Department of Atomic Engineering), India*** *at Indore. The work was later presented in the second talk in the series Talks and Lectures by Students (TaLeS).*

Primes is in P!

Professor Manindra Agarwal (HOD, Department of Computer Science and Engineering IIT Kanpur) was recently awarded the first ever Infosys Mathematics Prize, jointly instituted by Infosys and NIAS (National Institute of Advanced Studies) for his outstanding work in complexity theory, the branch of mathematics concerned with the study of algorithms for solving mathematical and related scientific problems, especially their efficiencies and running times.

This prize is awarded to a nominated candidate who has made outstanding contributions-fundamental or applied -in any field of mathematics including the areas of pure mathematics, mathematical foundations of computer science and applied mathematics in natural, life and social sciences. Dr. Agarwal was chosen for the award of Rs. 10 lakh and a medal by a jury of eminent academicians, of which Dr. S.R. Srinivasa Vardhan, the Abel Prize awardee of 2007, was the chair.

Dr. Agarwal co-created the *AKS Primality test* with his former students Neeraj Kayal (currently Postdoctoral Associate at Rutgers University) and Nitin Saxena (currently Scientific Researcher at CWI, Netherlands), and won the 2002 Clay Research Award, the 2006 Fulkerson Prize and the 2006 Godel Prize. (along with his co-authors). This is the first deterministic algorithm to test an *n*-digit number for primality in a time that has been proven to be polynomial in *n*. This discovery resolved a long-standing problem of a fast test of primality, which had been the subject of intense

(L to R) - Prof. R.K. Thareja (Deputy Director, IIT-K), Prof. Manindra Agrawal (Head, CSE, IIT-K), Prof. S. G. Dhande (Director, IIT-K). (Date: 27/09/2008)

study in the field of mathematics and computer science research.

NERD team got the opportunity to have a short interview with Dr. Agarwal regarding research initiatives at IIT Kanpur. The chairman of the organizing committee of IIT Kanpur REACH symposium 2007 said, "As NERD is to encourage students; REACH symposium is to encourage students as well as faculty to learn from each other. We get to know what research is happening in other departments as well and discover connections between them." He expressed his views on current UG curriculum as, "The total courses required to graduate should be reduced. Some core courses have grown too disjoint in today's context. They should be replaced with departmental courses in the first year." The message he left for the students was, "Follow the passion not the package."

Gems of Geometry

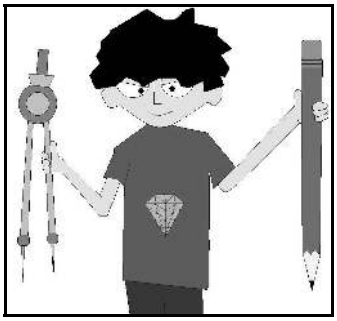
Problems that even a child can ask but even adults cannot answer

Manjish Pal

Introduction

Firstly, let me tell you what this article is all about. Since the title has the word 'Geometry', it is quite obvious that the content will have to do something with geometry. As far as the first word in the title is concerned its relevance will become clear as you proceed through the article. This article will try to give you a glimpse into the fascinating realm of 'Combinatorial Geometry', a branch of Mathematics that has flourished highly over the past 50 years.

Let me first explain what does 'Combinatorial Geometry' means. 'Combinatorial' is derived from the word Combinatorics, a branch of mathematics that deals with problems related to counting. So, combinatorial geometry is a study of counting problems in geometry (throughout this article geometry will be assumed to be Euclidean). Most of us must have noticed (during the JEE preparation or in High School!) that problems on counting are very easily statable but it may require a bit little effort to solve those. The answer to the question why the field of combinatorial geometry flourished so much can be easily obtained if we stretch the adjectives of the previous sentence in the following manner - the problems pertaining to combinatorial geometry are extremely easy to state but notoriously difficult to solve. Paul Erdős, one of the most prolific mathematicians all times (who wrote around 1500 papers during his life-time!) and one of the founders of this field once remarked "there are problems in combinatorial geometry that a child can ask but even adults cannot answer ".



In this article, I will try to give you a flavor of how some of these problems look like. Interestingly, each of these problems can be explained easily to a class 10th student, but researchers are still waiting for a solution of these (for a very long time). Lot of research that went into solving these problems created new fields in geometry and led to new techniques, some of which could unify diverse fields of mathematics like algebra, complex numbers and number theory. Before going into the problems, I need to give a quick primer on asymptotic notation which is needed if you want to understand the language of the known results on these problems. If you are not bothered about those, you can skip this section and directly go to the problems.

Asymptotic Notation

Let f (n) and g(n) be two functions defined over the domain of natural numbers. We say

1. f (n) = O(g(n)), if for sufficiently large n, f (n) ≤ cg(n) for some constant c > 0. More precisely, for all n > n_0, f (n) ≤ cg(n) for some natural number n_0 and constant c > 0 (here constant means independent of n). For example one can easily verify that $n = O(n^2)$, $n \log n = O(n^2)$.

2. f (n) = Ω(g(n)), if for sufficiently large n, f(n) ≥ cg(n) for some constant c > 0. More precisely, for all n > n_0, f (n) ≥ cg(n) for some natural number n_0 and constant c > 0. For example $n^2 = \Omega(n)$, $2^n = \Omega(n^k)$ for any constant k > 0.

3. f (n) = Θ(g(n)), if for all n > n_0, f (n) ≥ c_1g(n) and f(n) ≤ c_2g(n) for some constants $c_1, c_2 > 0$. For eg. $3n^2 = \Theta(2n^2) = \Theta(n^2)$. If for sufficeintly large n, f (n) ≤ g(n), then g (n) is called an upper bound for f (n) and f (n) is called a lower bound for g(n). Now, we are all set to go into the problems.

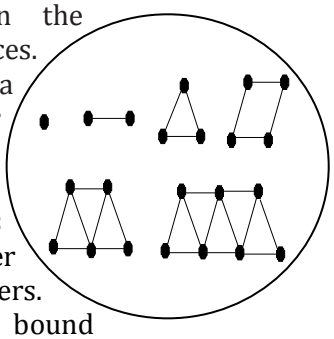
Problems

In rest of the article, no two points will be assumed to have the same coordinates. Moreover, n points in the plane will be said to be in general position, if there does not exist three points among these which lie on a line. In rest of the article, e stands for the base of the natural logarithm.

Erdős's Unit Distance Problem

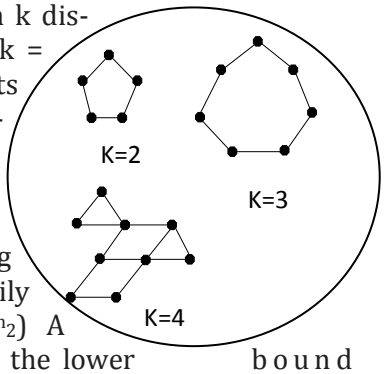
What is the maximum number of occurences of the same (unit) distance among n points in the plane? Let us denote this number by u(n). For small values of n (till n = 14), exact values of u(n) is known. Eg: u(1) = 0, u(2) = 1, u(3) = 3, u(4) = 5, u(5) = 7, u(6) =9 etc. The point configurations that achieve the maximum for these values are shown in the figure

aside. The line segment in the figures denote unit distances. Erdős[1] proved that, a $\sqrt{n}\times\sqrt{n}$ section of integer lattice can be used to show that u(n)≥ne^(c log n/log log n). The proof involves use of elementary number theory and complex numbers. Whereas, the best upper bound known is $u(n)\leq O(n^{4/3})$ at least 4 different proofs of this upper bound are known [2], [3],[4],[5]. In his original paper [1], Erdős himself proved that $u(n) \leq O(n^{3/2})$ and conjectured that $u(n)\leq O(n^{1+\varepsilon})$ for all $\varepsilon > 0$.



Erdős's Distinct Distances Problem

What is the minimum number of distinct distances determined by n points in the plane? Let us denote this number by d(n). In this case the exact values of d(n) is known till n = 13. d(1) = 0, d(2) = 1, d(3) = 1, d(4) = 2,d(5) = 2, d(6) = 3 etc. The figure shows optimal point-sets with k distinct distances, where k = 2, 3, 4. The line segments in the figure aside denote unit distances. This problem is closely related to the previous problem. By a counting argument one can easily show that $u(n)d(n)\geq \binom{n}{2}$ A construction similar to the lower bound of the previous problem gives an upper bound of O ($\sqrt{n}/\log n$). Erdős conjectured that $d(n) \geq O(n^{1-\varepsilon})$ Currently the best known lower bound d(n) is $d(n) \geq c_\varepsilon n^{[(48-14e/55-16e)-\varepsilon]} \geq \Omega(n^{0.8641})$ for every positive ε. Here c_ε is constant depending on ε.



Kissing Tetrahedrons

Given a geometric object C in 3 dimensions, let N (C) be the maximum number of non-overlapping congruent copies of C that can be arranged so that each of them is touching (kissing) C. This number is called the Newton Number of C .If B^3 is the 3-dimensional unit sphere then it is well known that $N(B_3) = 12$. The following question is about the kissing numbers of regular tetrahedrons. *What is the Newton Number of the regular tetraheron in R^3*? This problem still awaits a satisfactory answer.

Point-Line Incidence Problem

A point-line incidence is a pair (p, l) where p is a point and l is a line, such that l passes through p. *What is maximum number of point-line incidences I (n, m), determined by n points and m lines?* For small values of m and n one can easily construct arrangement of points and lines that achieve the optimal value. The first non trivial result shows that $I(n, m) \leq O(n\sqrt{m}+m)$. Erdős again using a section of integer lattice was able to show that $I(n, m) \geq \Omega(n^{2/3}+m^{2/3}+n+m)$and conjectured that asymptotically it is tight. Later Szemeredi and Trotter [7] via a convoluted argument showed that the conjecture is in fact true i.e. $I(n, m)\leq O(n^{2/3}+m^{2/3}+n+m)$.

The proof of this result was drastically simplified by Szekely using the notion of crossing numbers. An important open question regarding this problem is to determine the constant hidden in the asymptotic notation. The best known results in this direction are the following $0.42n^{2/3}m^{2/3}+n+m \leq I(n,m)\leq 2.5n^{2/3}m^{2/3}+n+m$

Concluding Remarks

It is obvious that a set of 4 problems can not give somebody an idea about how deep the field is but they can definitely rouse curiosity among the readers to explore further what this field is all about. they can definitely rouse curiosity among the readers to explore further what this field is all about. I believe this 'tip of the iceberg' will surely be able to prompt some readers to widen their horizon of knowledge in this direction.

Ponder Yonder

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Tandetron Particle Accelerator Facility

Institute forays into particle research

Indranuj Dey

Introduction

The Tandetron is a linear particle accelerator, in which the charged particles (usually ions) are accelerated in a straight line by application of appropriate electric fields, towards a target. The CRT (Cathode Ray Tube) screen of a television set is the simplest example of a linear machine, where electrons are accelerated instead of ions.

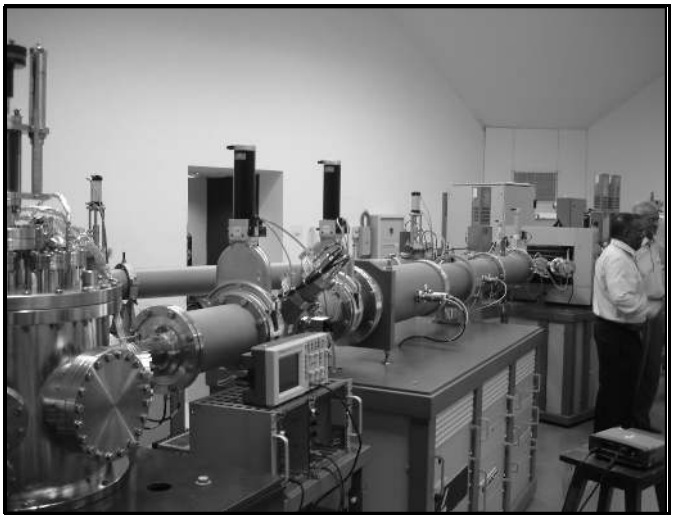
In a Tandetron, negatively charged ion gains energy by being attracted by the very high positive voltage at the geometric centre of the pressure vessel. When it arrives at the centre region known as high voltage terminal, some electrons are stripped from the ion. The ion then becomes positive and accelerated away by the high positive voltage. The accelerator therefore has two stages of acceleration, first pulling and then pushing the charged particles. Therefore, they are also called tandem accelerators.

Applications

Commercially available accelerators can have energies from 0.1 MeV to 60 MeV, depending upon applications. 1.7 MeV accelerators are very popular for applications in condensed matter, soft matter, and bio-chemistry. The commercial accelerators come equipped with various facilities like ion implantation, Rutherford Back Scattering (RBS), Particle Induced X-ray Emission (PIXE), Elastic Recoil Detection (ERD) etc. The ion implantation and RBS are the most widely used applications.

Facility inauguration at IIT Kanpur

The 1.7 MeV Tandetron particle accelerator is a central facility, under the supervision of Dr. V. N. Kulkarni, Department of Physics. The facility was inaugurated on the morning of 27th September 2008, in the Central Nuclear Laboratory – Northern Block, with invocation of Sanskrit Slokas, lightening of the lamp and steering of the particles for experiments. Many eminent and senior researchers from around India involved in particle accelerator and ion beam research were invited for this auspicious occasion. Dr. V. S. Ramamurthy, Dr. G. K. Mehta and Dr. S. Kailas also graced the occasion.



The inaugural session was followed by a technical session, where the progress of nuclear and ion beam research at IITK and the current Indian scenario was presented by Dr. R. M. Singru and Dr. D. Kanjilal respectively. Dr. V. K. Jain discussed the application of ion beams for micro-machining and fabrication of Micro Electro-Mechanical Systems (MEMS) which have a plethora of applications. A vision of futuristic plasmonics based opto-electronic devices due to the advent of meta-materials with negative refractive index, made possible by ion beam implantation was presented by Dr. S. A. Ramakrishna.

The interdisciplinary application of the ion beam facility was further elucidated by Dr. S. Verma and Dr. A. K. Sinha, who talked about its application in self-assembled peptide structure and other areas of biological research. The session was concluded with presentations by Dr. V. N. Kulkarni and Dr. S. Bhattacharjee on the ongoing research with the currently operational Focused Ion Beam (FIB) facility for nano-technological applications, and the indigenous development of an unique plasma based Multi Elemental – Focused Ion Beam (ME – FIB).

Indranuj Dey (indranuj@iitk.ac.in) is a Research Scholar working in the field of microwave generated magnetically confined plasmas under Dr. S. Bhattacharjee in the Department of Physics. He is interested in non-linear wave plasma interactions and its application to nanotechnology, space – propulsion and fusion.

Spectroscopy of Jet Cooled Molecules

Spectroscopy for dummies

Dr. V. Ramanathan

Introduction

Matter and radiation fill most of the universe that we live in. Spectroscopy is the branch of science that is mostly concerned with the studies of the electromagnetic radiation after its interaction with the matter. In other words, the radiation hits the matter and spectroscopy deals with the study of the radiation after it hits the matter in order to understand the physical properties of the matter. Here, the matter can exist in any of the four phases (solid, liquid, gas and plasma) and the radiation can range all the way from gamma rays (very high energy and wavelength) to radio waves (very low energy and wavelength). Depending on the nature of the electromagnetic radiation, the spectroscopy assumes different names like Nuclear Magnetic Resonance Spectroscopy (using Radio waves), Microwave spectroscopy (using microwaves), nfra-Red Spectroscopy, Electronic Spectroscopy (using ultra-violet radiation) and X-Ray Spectroscopy (using X-rays). Since these radiations differ in their energy, they interact with the matter differently and hence the information that is discerned about the physical properties of the matter also varies.

The efficacy of spectroscopy can be gauged by the realizing the fact that it gave birth to quantum mechanics. It was the explanation of the hydrogen atom spectrum that opened new vistas and an entirely new subject emerged out. Through spectroscopy one can get thorough understanding of the physical properties of matter which is of immense importance in understanding its other dynamical properties. Hence for varied reasons spectroscopy is highly indispensable and at nstances inevitable tool to probe the physical properties of matter.

Over the past hundred years or so, both theoretical and experimental knowledge has thrown more light into the structure of matter. Most of the observed properties of the matter can be explained by the complete knowledge of the molecular structure. Matter comprises of molecules which in turn is a complex connection of different kinds of atoms. For a molecule, the energy of a molecule can be viewed as trapped in different "states." There are different such states like the electronic, vibrational and the rotational states. Using different frequencies of electromagnetic radiations, these states can be accessed and hence their population can be altered. Altering the population of a state amounts in bringing about transition from one state to the other and this achieved by impinging the electromagnetic radiation of energy that correspond to the energy difference between the two states involved. Ultra-violet and visible radiations are used to bring about transitions in the electronic states, infra-red for the vibrational and microwave for the rotational states of a molecule. In this article, we discuss about the electronic spectroscopy, involving ultra-violet radiation.

As mentioned, electronic spectroscopy involves the electronic states of a molecule. In general spectroscopy can be performed with the matter being in any of the four states ie., solid, liquid gas or plasma. It is the inter-molecular interaction that distinguishes these states (with an exception of plasma). Hence the kind of spectrum that one obtains looks different in all these different states of matter. The idea is to access these states of a molecule with much less interference from other molecules or the surroundings. This is intended so as to make the spectrum appear less congested and hence good analyses. One immediate way out that is easily accessed is reducing the temperature of the substance. But mere reduction of temperature would just condense the system and still we would have inter-molecular interactions and this would still contribute to the complications of the spectrum. One method serves as the best way-out and that is supersonic jet expansion wherein the desired molecule is cooled to appreciably low temperatures (<10K) but still the molecules remain in the gas phase. The physics behind this cooling is described in the following sections.

Supersonic jet expansion

There are a number of excellent reviews available in the literature enumerating the salient features of supersonic jet expansion [1-12]. Before giving the principles behind cooling by supersonic jet expansion, a brief discussion about various broadening observed in the spectral lines are discussed. This

prelude would in a way serve as a rationale for the use of supersonic jet expansion technique for studying electronic spectroscopy of organic molecules. All spectral lines that we observe get broadened because of various factors. Following is a brief description of these factors.

There are three important factors that contribute to the line width and shape. They are briefly discussed in the following paragraphs.

Line width

A) Natural line width

The decay of species M* from an excited state E_n to ground state E_m is a first order process and the rate for the same is given as

$$-\frac{dN_n}{dt} = kN_n$$

with k as the first order decay constant and $1/k = \tau$. Here τ is the time taken for N_n to fall to 1/e of its initial value and is the lifetime of state n. Assuming that spontaneous emission is the only process by which M* decays, using Heisenberg uncertainty principle, the spread in frequency (lifetime) is given as

$$\Delta\upsilon \geq \frac{32\pi^3\upsilon^3}{(4\pi\varepsilon_0)3hc^3} |R^{nm}|^2$$

with the transition moment R^{nm} and other symbols are used representing standard conventions. From the relation it is evident that the spread it related to the third power of the frequency. This results in a much larger value for excited electronic state (~30MHz) and than for an excited rotational state (~10^{-4} to 10^{-5} Hz). Of all the broadenings, this is relatively very small and can not be removed. This is intrinsic to the system.

B) Doppler Broadening

If an atom or molecule is traveling towards the detector with a velocity υ_a, the ν_a frequency, at which a transition is observed to occur is related to the actual transition frequency ν in a stationary atom or molecule by

$$\nu_a = \nu\left(1 - \frac{\upsilon_a}{c}\right)^{-1}$$

where c is speed of light. Because of the usual Maxwell velocity distribution, there is a spread of values ν_a and a characteristic line broadening given by

$$\Delta\nu = \frac{\nu}{c}\left(\frac{2kt\ln 2}{m}\right)$$

where m is the mass of the atom or molecule this $\Delta\nu$ is normally greater than natural line width. This broadening is inhomogeneous and results in a Gaussian line shape. For further discussions on these topics, the reader is advise to consult Reference [13].

C) Pressure broadening

When collisions occur between gas phase atoms or molecules there is an exchange which leads effectively to a broadening of energy levels. If τ is the mean time between collisions and each collision results in a transition between two states there is a line broadening $\Delta\nu$ of the transition where $\Delta\nu=(2\pi\tau)^{-1}$ derived from uncertainty principle. This is a homogeneous broadening and produces a Lorentzian line shape except for transitions at low frequencies when unsymmetrical line shapes results.

Besides these factors, when a molecule contains a flexible group, an UV absorption spectrum becomes highly congested and only a broad and structure-less feature is observed. Few of these broadenings are removed when the molecule under study exists at low temperature and in isolated conditions. This is verily achieved in molecular beams and especially in supersonic jet expansion.

The technique of molecular beams has become popular ever since the elegant demonstration by Stern and Gerlach [14]. The use of effusive beam is well documented in the literature. Supersonic jet expansion is a novel technique that followed the effusive beam era. In the following paragraphs, the principle behind supersonic jet expansion is discussed briefly.

Cooling by supersonic jet expansion

Let λ be the mean free path of a gas expanding through a tiny orifice of diameter 'a' such that $\lambda << a$. this implies that the molecules suffer many collisions during their passage through the orifice. Expansion occurs rapidly and no heat exchange occurs between the gas and wall, thereby making the expansion adiabatic and the enthalpy per mole of the gas is conserved. The total energy E of a mole of gas with mass M is the sum of internal

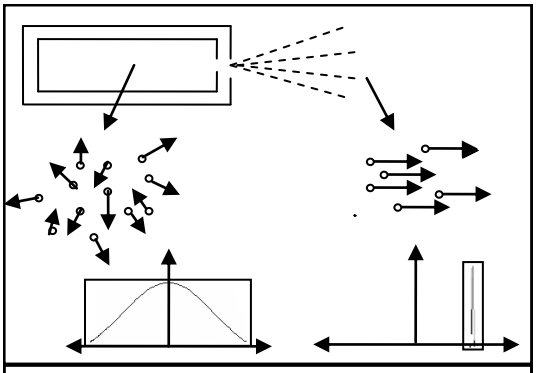
energy U = U_{trans} + U_{rot} + U_{vib}, potential energy pV and kinetic flow energy 1/2Mu², u being the mean flow velocity. Energy conservation demands for the total energy before and after expansion to be equal.

$$U_0 + p_0V_0 + \tfrac{1}{2}Mu_0^2 = U + pV + \tfrac{1}{2}Mu^2$$

With the flow dM/dt through the orifice being small compared to the total mass of the gas in the reservoir, $u_0 = 0$ can be assumed without any loss of generality. Secondly, the gas expands into the vacuum chamber, the pressure after the expansion is small implying $p << p_0$ and hence it is also assumed that p = 0. Thus the energy conservation equation gets transformed to

$$U_0 + p_0V_0 = U + \tfrac{1}{2}Mu^2$$

This implies that a cold beam with a small internal energy U is obtained when most of the initial energy $U_0+p_0V_0$ is converted into kinetic flow energy 1/2Mu² When the flow velocity exceeds the local velocity of sound c(p, T), supersonic beam is produced. The decrease of the internal energy implies a decrease in the relative velocities of the molecules. The rationale being that the faster molecules collide with the slower ones and transfer kinetic energy. This entire process is depicted in the figure below.



Schematic view of expansion resulting in directed mass flow and non-Maxwellian velocity distribution

The energy-transfer rate decreases with decreasing relative velocity and decreasing density is therefore important only during the first stage of expansion. Head-on collisions with impact parameter zero narrow the velocity distribution $n(v_{||})$ of velocity components $v_{||} = v_z$ parallel to the flow velocity u in the z-direction. This results in a modified Maxwellian distribution

$$n(v_z) = C_1 \exp\left(-\frac{m(v_z-u)^2}{2kT_{||}}\right)$$

around the flow velocity u. this distribution may be characterized by the translational temperature $T_{||}$-, which is a measure for the width of the distribution given by the above equation and C_1 being a constant. Stabilizing collisions of the molecules during this adiabatic expansion narrow this velocity distribution and the most probable velocity approaches the flow velocity. Consequently the rotational energy U_{rot} and the vibrational energy U_{vib} decreases and this results in compression of the population distribution n(v, J) into the lowest vibrational and rotational levels.

The temperature, pressure, density and Mach number profiles of the bath atomic gas (assuming perfect gas behavior) are related by following equation .

$$\frac{T}{T_0} = \left(\frac{P}{P_0}\right)^{(\gamma-1)/\gamma} = \left(\frac{\rho}{\rho_0}\right)^{\gamma-1} = \frac{1}{1+\frac{1}{2}(\gamma-1)M^2}$$

where T_0, P_0 and r_0 are the temperature, pressure and density of the gas in reservoir; T, P and r are the same quantities in the post-expansion region. g is the heat capacity ratio C_p/C_v; and M is the Mach number, which is the ratio of the flow velocity to the local speed of sound. For a continuous gas at distances greater than a few nozzle diameters from the orifice, it has been shown [3] that the Mach number is given by

$$M = A(X/D)^{\gamma-1}$$

where X is the downstream distance, D is the nozzle diameter and A is a constant that depends on g. For a monoatomic gas g = 3.26. In most cases, translational and rotational temperatures are ~1 K and ~10 K, respectively.

The cross sections $\sigma_{vib\text{-}trans}$, $\sigma_{vib\text{-}rot}$ and $\sigma_{rot\text{-}trans}$ are the quantitative measure of the transfer of energy taking place during the collision. In the post expansion region it is seen that $\sigma_{vib\text{-}trans}$ or $\sigma_{vib\text{-}rot}$ are much smaller than $\sigma_{rot\text{-}trans}$ .This implies that cooling of vibrational energy is less effective than that of E_{rot}. Thus, in the post expansion region, $T_{trans} < T_{rot} < T_{vib}$. When two atoms recombine during expansion to form a dimer, the binding energy is transferred to a third atom. This results in the heating of the cold

beam and hence preventing the attainment of lowest values of translational temperature. Since the binding energy of noble gas atoms is very small, this heating effect is negligible. Hence the lowest translationa temperature can be attained with supersonic beams of noble gas atoms.

In the experiments undertaken in this work, the molecule of interest is seeded in helium gas. Seeding in noble gas atoms helps in lowering the T_{rot} because the cold bath of the atoms acts as heat sink for the transfer of the rotational energy of the molecules to the translational energy of the atoms.

Illustrative examples

Spectrum of a molecule that is recorded in condensed phase in a conventional manner is shown in figure1.

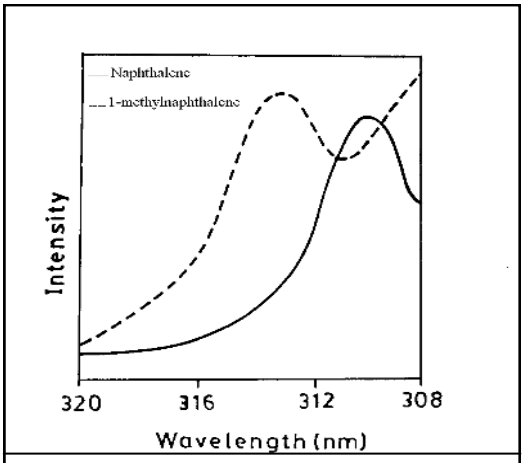


Figure1:Absorption Spectrum in condensed phase

Above is the fluorescence absorption spectrum of Napthalene and 1-Methylnaphthalene recorded in the condensed phase. From the spectrum, we can only infer the λmax values and all other features are enveloped by the broad feature in the spectrum. Alternatively if the fluorescence excitation (which is in fact similar to the fluorescence absorption) spectrum in the supersonic jet expansion conditions, the spectrum appears as shown in figure2.

Fluorescence excitation spectrum (similar to absorption spectrum) in jet expansion conditions It should be noted that the horizontal axis is identical in both the spectra but the nature of the spectrum completely changes. The spectrum has become reasonably sharp. This is called the vibronic spectrum as vibrational features are accessed by performing electronic excitation in the molecule. This change in the nature of the spectrum is the result of carrying out the experiment in supersonic jet expansion conditions. Although it should also be noted that the excitation source (radiation source) employed to get the spectra displayed in Figures 2 and 3 are different with conventional lamp in the former and laser in the latter. This difference also plays a major role in reducing the broadening of the peaks in the spectrum. For more detailed treatment of the influence of Laser in spectroscopy, readers are directed to consult References 13 and 15.

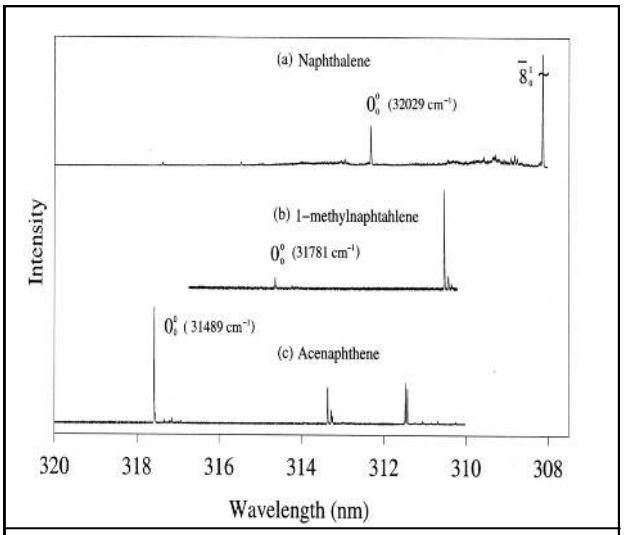


Figure2:Fluorescence excitation spectrum (similar to absorption spectrum) in jet expansion conditions

Conclusion

Cooling molecules by supersonic jet expansion provides a neat handle to probe the electronic structural details of a molecule. The combination of supersonic jet expansion and several novel laser spectroscopic methods, the physical details of a molecule can be discerned with reasonably high accuracy.

Ponder Yonder

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Dr. V. Ramanathan is an alumnus of IIT Kanpur. He was a PhD student in the Department of Chemistry here from July 2003 till Aug 2008 and he worked in laser induced fluorescence spectroscopy of selected organic molecules towards his thesis. His supervisors were Dr. T. Chakraborty (currently at Indian Association for the Cultivation of Science, Kolkata) and Dr. Debabrata Goswami (dgoswami@iitk.ac.in). Currently he is pursuing his post doctoral studies at Seoul National University, South Korea working in the Molecular Reaction Dynamics Lab. His research interests are chiefly in the domain of electronic and vibrational spectroscopy with special interests in the application of different spectroscopic metholodologies for various kinds of diagnostics.

His comments on NERD: *"NERD indeed is a productive initiative in the direction of promoting thoughtful activity among the students. I wish it has a healthy childhood followed by an everlasting youth!!!"*

See 'Jesus Christ' Running on Water!

Ever heard of a lizard which can 'walk and run' on water? A lizard known as 'Jesus Christ' lizard (Basilisk) can generate sufficient momentum to run on top of water for a distance of 15-20 m, when fleeing from a predator. This reptile generates the momentum with their feet that keep their bodies both above the surface and upright. They can run up to seven miles per hour and are excellent climbers, swimmers and jumpers.

Found in Central and South America rainforests near rivers and streams, it belongs to the iguana family. Their average lifespan is about seven years. They usually weigh up to 600 grams and grow up to 25 cm (1 foot). It feeds on insects, flowers and small vertebrates like snakes, birds, eggs and fish. Like other lizards, the basilisk can store fat in its tail.

They have long toes and sharp claws, and their head is adorned with both a crest and a colored dewlap. They have green turquoise, or brown coloring and their outstanding camouflage allows them to remain undetected when they remain motionless in the undergrowth. It is a diurnal lizard.

Basilisks have large hind feet with flaps of skin between each toe, much like the webbing on a frog. These are rolled up when the lizard walks on land; but if the basilisk senses danger, it can open up this webbing to increase the surface area on the water

Basilisk Lizard running on water *(**Source:** National Geographic)*

relative to its weight, thus allowing it to run on water for short distances. Smaller basilisks can run about 10-20 meters on the water surface without sinking, and can usually run farther than older basilisks.

But how do they run across sand, gravel or dirt? Lack of such answers is holding up the development of technologies. It's one of the major reasons we can't build effective legged robots. (http://www.youtube.com/watch?v=45yabrnryXk)

Ponder Yonder

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It's noble to be an Ig Nobel!

Achievements that "first make people laugh, and then make them think"

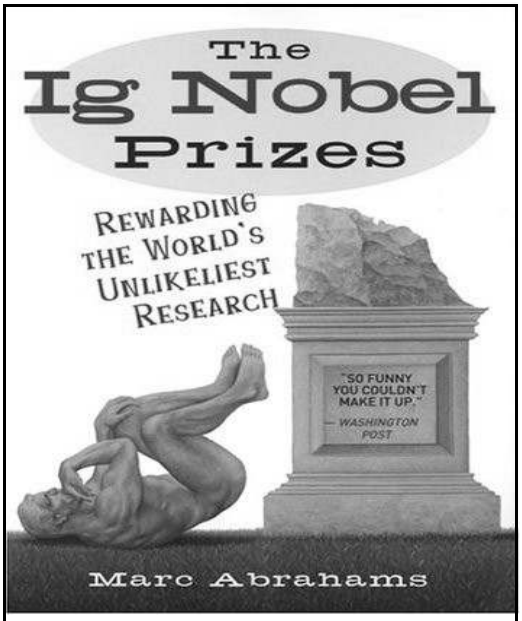
Puneet Singh

Introduction

Since 1901, the Nobel Foundation has been awarding the most prestigious prizes in the world to people who have conferred great benefit to mankind in Peace, Literature, Chemistry, Medicine and Physics. However, in 1991, the scientific humor magazine, Annals Of Improbable Research, initiated a different set of awards-The Ig Nobel Prizes.

These awards are given to discoveries "that cannot, or should not, be reproduced." They honor ten achievements that "first make people laugh, and then make them think."

It is not as improbable as it sounds, many of the 976 co-winners of the 1993 Ig Nobel Literature Prize may still be unaware of their good fortune. It's not clear whether these individuals, who co-authored a paper that was published in the *New England Journal of Medicine* (vol. 329, no. 10), ever exchange information or hellos, or have even heard each others' names spoken. Their paper was remarkable for having 100 times as many authors as pages - that is what won them the prize.



Marc Abrahams is the editor and co-founder of *Annals of Improbable Research,* and the originator of the annual *Ig Nobel Prize Celebration.*

Sources: *http://en.wikipedia.org/wiki/Marc_Abrahams (http://yr.updateordie.com/geral/2007/10/ig-nobel-2007/)*

The Award Ceremony

The formal ceremony takes place at Sander's Theater in Harvard University. (Genuine) Nobel Laureates present the prize to the winners. The Ig Informal Lectures are held at MIT a few days later where the winners get chance to explain their research and its relevance to the masses. These lectures often become long winded and an eight year old girl Miss Sweety Poo interrupts the proceedings by repeatedly crying out in a high pitched voice, "Please Stop. I'm Bored". Throwing Paper planes on the stage was a long standing tradition and the 'Keeper of The Broom' physics professor Roy Glauber swept the stage clean. In 2005, he was absent from the ceremony as he was on his way to accept a genuine Nobel Prize in Physics. Art and Science go hand in hand, so at the Ig Nobels, delegates from the Museum of Bad Art display pieces from their collection.

This year's Ig Nobel winners were awarded in Physics for proof that heaps of hair or string will inevitably tangle. Two research teams were jointly awarded the Ig Nobel in Chemistry, one for discovering Coke as an effective spermicide and the other for proving it is not.

Indians fare well at Ig Nobels

Indians haven't done well in the Nobel prizes but this is not the case here. The most famous one is of Lal Bihari who won the prize for Peace in 2003 for a triple accomplishment- for leading an active life even though he has been declared legally dead; for waging a lively posthumous campaign against bureaucratic inertia and greedy relatives; and for creating the Association of Dead People. Lal Bihari overcame the handicap of being dead, and managed to obtain a passport from the Indian government so that he could travel to Harvard to accept his Prize. However, the U.S. government refused to allow him into the country. His friend therefore came to the Ig Nobel Ceremony and accepted the Prize on his behalf. Several weeks later, the Prize was presented to Lal Bihari himself in a special ceremony in India.

L. Mahadevan, an alumnus of IIT Madras was awarded the Ig Nobel 2007 in Physics for studying how sheets become wrinkled. Gauri Nanda of MIT won the Ig Nobel 2005 in Economics for inventing an alarm clock that runs away and hides, repeatedly, thus ensuring that people *do* get out of bed, and thus theoretically adding many productive hours to the workday.

The Ig Nobel in Mathematics 2002 went to K.P. Sreekumar and the late G. Nirmalan of Kerala Agricultural University, India, for their analytical report "Estimation of the Total Surface Area in Indian Elephants." Not many were surprised when our ex-Prime Minister Shri Atal Bihari Vajpayee received the Ig Nobel prize for Peace along with our neighbour's PM Nawaz Sharif, for their aggressively peaceful explosions of atomic bombs. The Ig Nobel 2001 for Public Health went to Chittaranjan Andrade and B.S. Srihari of the National Institute of Mental Health and Neurosciences, Bangalore, India, for their probing medical discovery that nose picking is a common activity among adolescents. The Vatican won the Economics prize 2004 for 'outsourcing' prayers to India.

Ravi Batra of Southern Methodist University, shrewd economist and best-selling author of "The Great Depression of 1990" ($17.95) and "Surviving the Great Depression of 1990" ($18.95), for selling enough copies of his books to single-handedly prevent worldwide economic collapse won the Ig Nobel in Economics in 1993. 1998 Ig Nobel for physics went to Deepak Chopra of The Chopra Center for Well Being, La Jolla, California, for his unique interpretation of quantum physics as it applies to life, liberty, and the pursuit of economic happiness.

Conclusion

Summing up, the awards ceremony traditionally is: "If you didn't win a prize — and especially if you did — better luck next year!"

Ponder Yonder

1. *http://improbable.com*
2. *http://en.wikipedia.org/wiki/Ig_Nobel_Prize*

Puneet Singh (punsingh@iitk.ac.in) is a first year undergraduate student in the Department of Aerospace Engineering. He is nicknamed in the NERD team as 'the NERD SERD'.

Astronomer Grandma: Dr. Vera Rubin

'Dark matter' brought to light

Parul Singh

"*In a spiral galaxy, the ratio of dark-to-light matter is about a factor of ten. That's probably a good number for the ratio of our ignorance-to-knowledge. We're out of kindergarten, but only in about third grade."* —Dr. Vera Rubin

Introduction

Dr. Vera (Cooper) Rubin, a research astronomer at the Carnegie Institution of Washington, has done pioneering work on galaxy rotation rates. If you talk and debate so much about 'Dark Matter' today, it's because of her extensive research. Her discovery of what is known as 'flat rotation curves' is the most direct and robust evidence of dark matter.

To talk of how it all started, Rubin, at the age of 22, produced a controversial master's thesis in Cornell University, presented her findings in 1950 at a meeting of the American Astronomical Society, and promptly received a huge amount of publicity--all negative. Her thesis challenged the big bang theory which postulates that the universe is expanding out from an original central explosion of matter. Instead, she argued, the galaxies themselves are actually rotating around a central point, not just expanding out from it. Ironically, her thesis helped Gerard de Voucouleurs invent the idea of the super cluster. Her PhD thesis on the distribution of Galaxies at Georgetown University in 1954 told that galaxies were not evenly spaced throughout the universe. This was another controversial finding, since the big bang theory suggested that galaxies are evenly distributed. (However, more research gave her observations validity 15 years later.)

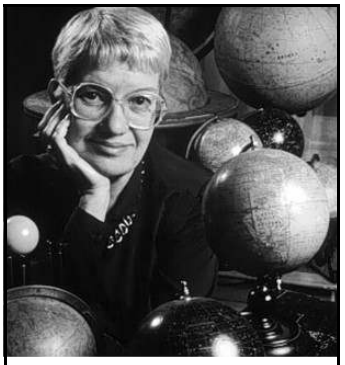
"Fame is fleeting," Rubin said when she was elected to the National Academy of Sciences. "My numbers mean more to me than my name. If astronomers are still using my data years from now, that's my greatest compliment."

Dynamics of galaxies and the dark matter

How bold could be destiny to lead astray a girl, who had been addicted to watching the constellations from the north-facing bedroom window of her home in Washington D.C. since her childhood? She fashioned a home-made telescope out of a cardboard tube and began scanning the night sky.

Vera joined the Carnegie Institutions' Department of Terrestrial Magnetism in 1965 and teamed up with Kent Ford, an astronomer who had developed an extremely sensitive spectrometer. Their work focused on observations of the dynamics of galaxies. When they began making Doppler observations of the orbital speeds in spiral galaxies, they discovered something out of the blue. The stars far from the centres of galaxies, in the thinly populated outer regions, were moving just as fast as those closer in.

This was odd, because the visible mass of a galaxy just does not exert enough gravitational pull to hold such rapidly moving stars in orbit; the stars should have been thrown out of the galaxy if the galaxy's mass was indeed the observed mass. It followed that there had to be a tremendous amount of unseen matter in the outer regions of galaxies where the visible stars are relatively few.



Dr. Vera Rubin
Source: http://www.astrosociety.org/education/resources/images/vera.jpg

Rubin and Ford went on to study some sixty spiral galaxies and always found the same thing. "What you see in a spiral galaxy," Rubin concluded, "is not what you get." Then Rubin remembered an exercise in graduate school that every student had to work through. It was based on measurements of galaxies in clusters made by Fritz Zwicky in the 1930's. He said that galaxies in clusters moved so fast that they must have some unknown matter (which he called "missing mass") that was gluing them together.

Realizing the dark matter

Rubin realized that the dark matter she and her colleagues had observed could be the missing mass Zwicky had predicted. Though the astronomers initially resisted the idea, Rubin's observations were so persuasive and their implications so straightforward that eventually they realized that Rubin has to be right. Since 1978, Rubin and a team of Carnegie postdoctoral fellows have analysed more than 200 galaxies. They estimate that 90% or more of the universe is made of this mysterious dark matter. In other words, everything astronomers had studied until the discovery of dark matter was only about one tenth of the universe. "With over 90% of the matter in the universe still to play with, even the sky will not be the limit."-Rubin chuckles. And just what is this 'dark matter', so far unobserved except by the effect of its gravity on the stars? The question is one of the major unsolved mysteries of astronomy today. Many theoretical and observational astronomers are hard at work trying to answer it.

Vera Rubin continues to explore the galaxies. In 1992, she discovered a galaxy (NGC 4550) in which half the stars in the disk are orbiting in one direction and half in the opposite direction, with both systems intermingled! Perhaps this resulted from the merging of two galaxies rotating in opposite directions. Rubin has since found several other cases of similarly bizarre behaviour.

Awards received

In 1993, Vera received the National Medal of Science– the nation's highest scientific award for her pioneering research which demonstrated that much of the matter in the universe is dark. She was elected to the National Academy of Sciences in 1981, and in 1996 she became the first woman to receive the Royal Astronomical Society's Gold Medal since Caroline Hershel, who was awarded the prize in 1828. Among her other honors, she won the Cosmology Prize of the Peter Gruber Foundation in 2002 and was chosen to be the American Astronomical Society's Henry Norris Russell Lecturer in 1994. She also received the James Craig Watson Medal in 2004.

Lessons to learn

Vera has also been very active in encouraging women and minorities to pursue careers in science. In an interview with DISCOVER magazine, Dr. Rubin advised the women pursuing careers in science, "I would say that if they really want to do it, to just go ahead, try not to let anything discourage them, try not to quit, but to recognize that academia is still not kind to women."

Sources:
1. http://www.sjsu.edu/depts/Museum/rubinv.html
2. http://en.wikipedia.org/wiki/Vera_Rubin
3. *http://www.dtm.ciw.edu//content/view/122/168/*
Visit http://www.nerdmag.org/ for more.

WIRED

"The first NERD magazine was very good. The questions/ quizzes were nice. I would like to suggest that NERD should contain a little more pictures/cartoons about the topic, because it will make it more visually attractive. Also there should a page or two about a dream project of a student." **Ratna Raj Singh (ratnar@iitk.ac.in)**

"The current edition of NERD is mind blowing. I would like to create a section in NERD having interesting scientific questions based on daily life experiences. We can also invite such questions from students. That will make NERD more interactive with students." **Sahil Baghla (sbaghla@iitk.ac.in)**
NERD replies: *Dear Sahil, Thanks for the advice. We hope 'Zonked!' section in this issue did not disappoint you.*

"The first effort of NERD is excellent. I found both the interviews pretty good and inspiring. The cover page was not so attractive though." **Nitish Kumar (knitish@iitk.ac.in)**

"To read the views of a person who is being idolized by so many of us through NERD's inaugural issue– Dr. H.C. Verma– was really great. However, the print should have been more colorful. Try making the scientific articles little humorous by adding a few quotes in between." **Bhuvnesh Goyal (bhuvnesh@iitk.ac.in)**

"The first issue of NERD was quite interesting though at first I did not think so, but on reading the magazine, I realized that NERD is for all of us, not only for NERDs." **Rohit Agarwal (rohitag@iitk.ac.in)**

"This issue of NERD had many elements that interested us, but look for a greater involvement of students to make it a world level magazine. A science fiction story writing competition can be organized within IIT K and the best being published in NERD." **Saurabh Singh (sausingh@iitk.ac.in)**

"Overall the magazine is quite good. The content is balanced. The language in certain articles is a bit amateurish, but I think it adds to the beauty of the NERD magazine, since it's by the students." **Indranuj Dey (indranuj@iitk.ac.in)**

"NERD's first issue was a satisfactory effort to make us aware of and inclined towards the research in the institute. The interview with Dr. Verma was an excellent part of it. More interesting articles (as CycleMAN) can be added." **Ravindra Singh Rajawat (ravraj@iitk.ac.in)**

"The interview with Dr. Verma was really appealing. The questions were both framed and replied well. I liked the questions in 'Zonked!' and the article 'Stepping Stones'." **Ankit Awasthi (aawasthi@iitk.ac.in)**

"The technical stuff in the first issue of NERD was a bit clustered which makes it a bit boring at times. Some light informal articles at regular intervals along with the technical stuff can bind the reader in a better way." **Puneet Chugh (puneetc@iitk.ac.in)**

"The book review in NERD was informative. Interesting interviews! There were no articles from Mathematics." **R. Bharadwaj (rlnb@iitk.ac.in)**
NERD replies: *Dear Bharadwaj, we did not receive any articles from Mathematics for issue 1 of NERD. We will try to ensure that subsequent issues have representations from all departments.*

*"*If there is any publication by IIT Kanpur related to any of the informal articles, we can include it as a reference after the article. For example, a book related to Bhopal Gas Tragedy kept in IITK Publication section on the 2nd floor of our library can be put in reference to the article 'Science behind the tragedies' in Vol. 1 No.1 of NERD." **Pranjal Nayak (pran@iitk.ac.in)**
NERD replies: *Dear Pranjal, we shall look out for such cases in subsequent issues of NERD.*

and the list continues…..so will NERD!!

What's up next?

Highlights of Vol. 1 No. 3 (Special issue) of NERD:

- **Intel-DST Award winners** (Tapendu Mandal and Prem Prakash) write about their achievement**s**
- **Teaching Engineering–** Interview with Dr. C.V.R. Murty (Distinguished Teacher Awardee, Teacher's Day 2008, IIT Kanpur)- by Mohit Jolly
- **Photovoltaic: Technology of next Millenium**– by Shitikanth
- **Carbon Trading–** by G. Ravikumar
- **DOG-EARED : ZOOM** (Book Review) — by Arvind Kothari
- **Indian patent on improved organic optoelectronic device—**by group members

And many more articles. Don't forget to grab your copy.

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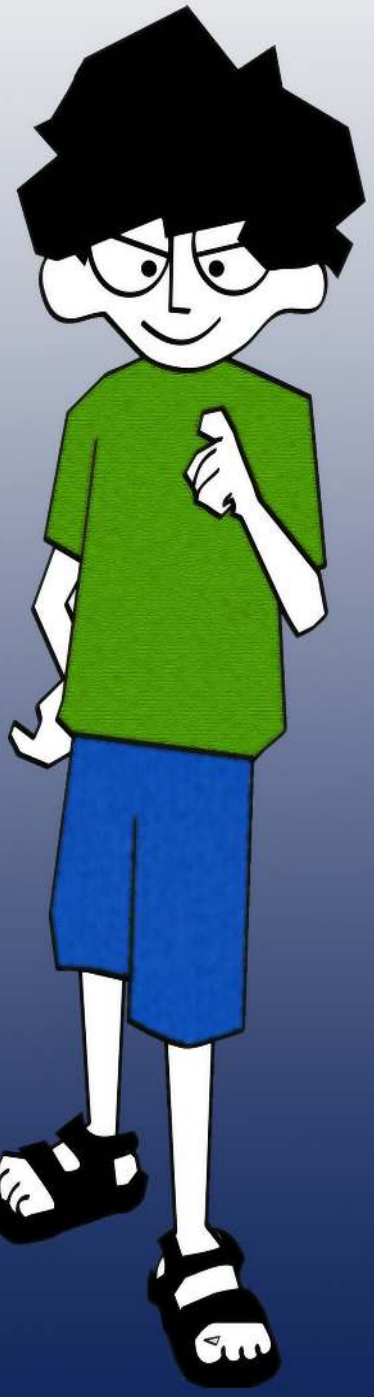
Volume 1 Number 3



Special Issue on ENERGY to be launched in

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12-15 Feb 2009

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